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MORE ABOUT THE SEA-HORSE.

BY SAMUEL LOCKWOOD.

THE July number of the AMERICAN NATURALIST for 1867 contains my article, "The Sea-Horse and its Young." Although the result of a long study of living specimens of this eccentric fish, yet some questions remained unanswered. At the time mentioned I was living at Keyport, on Raritan Bay. Early in 1870 my residence was changed to Freehold, fourteen miles inland, hence it has happened that specimens sent me have succumbed before reaching my home. A happy exception occurred November 1, 1884, in the arrival from Shark River of a fine large female *Hippocampus heptagonus* Rafin. As the subject of my article in 1867 was a male, I prized my new pet highly.

With an aquarium devoted entirely to this specimen, I set about studying her peculiarities. She had the same habit of converting her tail into a prehensile organ, and so would coil the tip around a tuft of sea-lettuce, and with the pretty dorsal fin in movement like an undulating ribbon, would sway to and fro, keeping the body erect. The sight of the sea-horse alive in the water is always pretty, although quite grotesque, for its action differs so greatly from that of other fishes, which are prone, and usually move in a line parallel to the bed of the water, while, as a child would express it, the sea-horse swims standing up on its tail. The crested head is erect,—the action though stiff is graceful, not unlike the knightly steeds on the chess-board, very quaint yet comely.

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I had through all those years desired to see the giving of the spawn by the female and the taking of it by the male; for, as shown in that article of 1867, the male Hippo is not only father but nurse to the young. In his front, just a little higher than the vent, is a sac, into which he receives the eggs of the female, and in which he hatches them. My desire was to see the method of taking the eggs into this pouch. Did he put them in or did she? Despairing now of ever seeing them in apposition, I must describe the act as I think it does take place.

I cannot believe that the twain are without emotion, since it is true of some of the higher fishes that the love-season calls out their intelligence to its highest manifestation. Suppose in our latitude it is July. A pair of these Hippocampi meet. They curl their prehensile tails about each other and assume an erect position, face to face. The female emits her eggs in a slow stream immediately over the pouch, which opens and closes at the top. The motion of the mouth of this sac is that of suction, thus the eggs are actually drawn into it. There they are patiently hatched and also nourished, as shown in the paper referred to. This apposition of the sexes, to be sure, is hypothesis, yet I think it will prove to be true. At any rate it is the outcome of long and patient thought, and is perfectly consistent with observation of habit.

When the young are ready for eviction, the pouch, which on receiving the eggs was fat and thick, has become flaccid and thin. Its adipose lining has been absorbed by the young fishes. So badly wasted is the pouch that muscular action sufficient to expel the brood is impossible. The father-fish evicts his charge in the following way. He gets himself in an erect position alongside of some object, a stick, stone, shell, or plant, either hooking the end of his tail under it, or in some way getting hold by its prehensile tip. Then stiffening the whole body and keeping it erect, he leans upon the object and brings himself down against it with a jerky movement; this rubs up the pouch, pushing out some of its occupants. This is done repeatedly until the whole brood is forced into the water.

Now, it is observable that an anal fin would be greatly in the way during such an operation. In fact, it would be a very bad obstruction. Hence the absence of this fin in the male Hippocampus. But it is present in my female, for in her case it

is not in the way. In fact, it may be that she utilizes it at the time of emitting her spawn, as she could produce a gentle eddy of the water in the direction of the male's pouch.

I found by the microscope that diatoms were being generated in the tank, and I fancied that my pet was feeding on them, for in all my devices I did not succeed in feeding her myself. She would show a movement in her tubular snout which looked like sucking something in. Sometimes she would stretch herself on the bottom of the tank and apply the tip of her nozzle in a way that seemed to me like selecting by sight. And what a cunning look! as with sacerdotal steadfastness of purpose one eye was turned towards heaven and the other kept upon the earth. Certainly her food was microscopic, and in the hunt her optical application was binocular or monocular at will.

I noticed with some concern that the peculiar scales which covered its body, and looked not unlike plate armor, were becoming green. It proved that a growth of micrococci had set in, and was rapidly spreading over her. I was quite solicitous about it; for it would hardly do for me to clean it, so tender is the little creature. Its tank had become badly infested with these unicelled algæ. For the purpose of keeping up a supply of microscopic life for its food, besides the little two-gallon aquarium, I kept two specie jars going, and would transfer it to them, so that it could have freshness of food. Deciding to clean up the aquarium, I put it in one of the jars. It quite enjoyed the change, and to my surprise performed a series of movements on the clean sand, which turned out to be successful efforts to scour off the green parasitical slime. It needed patience, but that, with perseverance, did the work.

She was in a few days put back into her aquarium. The little handling necessary always begat a discernible clucking as of terror. It was really a species of snapping of the lips of the tubular snout. I heard it often, and under different circumstances, and thought I could detect three intonings,—one which was excited by terror, one denoting a pleasurable emotion, as when in play, and a third when quite still, perhaps faintly like the purring of another pet. But perhaps my intense sympathy with the little creature may give color to these interpretations.

Alas, there was now too much ground for sympathy,—a terrible malady had begun to take hold of the poor thing. The face

took on a comical aspect. On each side rose a swelling as if she had the mumps. With a hand-lens I found that these were blisters, white vesicles, and so buoyant as to annoy her by producing eccentric movements. I contrived to pierce them with a needle, and so to let out the confined gas. This gave immediate relief. But they came again, and by and by my surgery did not avail. They increased, and the buoyancy would raise it to the surface, and the little sufferer despite all help would float. And so it was on the last day of February at an early hour I found poor Hippie afloat on her beam ends and dead. I had her alive just four months, and the above is but a tithe of what might be told of her pretty ways.

THE TACONIC QUESTION RESTATED.

BY T. STERRY HUNT.

§ 1. So much obscurity and misconception still exist in the minds of most geologists regarding what have been called the Taconic rocks, that it seems desirable to set forth clearly, and more concisely than has yet been done, the principal facts in the history of the two wholly distinct and very unlike groups of strata which have hitherto been included under this title, and which occupy very important places in American stratigraphy as well as in economic mineralogy. For a clear understanding of these strata, which, as originally described, lie between the crystalline schists of western New England and the continuous area of rocks belonging to the Ordovician (Chazy-Loraine) period, found along the Hudson and Champlain valleys, we must go back to the writings of Amos Eaton, in which we find, as early as 1832, a concise but complete exposition of the great stratigraphical problems presented by the region in question. The gneisses, with hornblendic and micaceous schists, of the Atlantic belt were then regarded by Eaton as the slaty or argillaceous member, constituting the lowest division, of his triple series of Primitive rocks; and were declared by him to be there followed by the second or silicious, and the third or calcareous member of the same series. These were the Granular Quartz-rock and the Granular Lime-

rock, by which names he designated the quartzite and the crystalline limestone of the Taconic (or Taghkonic) Hills in western New England.

§ 2. Above the Primitive, Eaton placed the Transition series, including, like the last, three divisions: First, at the base, a schistose or so-called argillaceous member, named by him the Transition Argillite, and representing in this second series the gneisses and crystalline schists of the Primitive. Second, a silicious member, consisting of a great group chiefly of sandstones and conglomerates, comprehensively described by him as millstone-grit, rubble, and graywacke-slate, the whole representing in the Transition series the Quartz-rock of the Primitive, and called the First Graywacke or Transition Graywacke, a term borrowed from German geologists. Third, a limestone named by him the Sparry Lime-rock, and representing in this series the Granular Lime-rock of the Primitive. Eaton insisted upon the existence of a stratigraphical break, and a discordance, between the Transition Argillite and the overlying Transition Graywacke, the distribution of which latter was described in detail. It was said to be "seen resting on the Argillite in Rensselaer County, where its subdivisions form a ridge which extends from Canada through the State of Vermont, and Washington, Rensselaer, and Columbia Counties in New York." The conglomerates of this Transition Graywacke were further said to make "the highest ridges between the Massachusetts line and the Hudson."

§ 3. To the west of Lake Champlain, along the base of the Macomb Mountains (since called the Adirondacks), and resting upon the Primitive gneiss, Eaton found what he called the Calciferous Sand-rock (a magnesian limestone, sometimes holding gypsum), which he declared to be the equivalent, in this region, of the Sparry Lime-rock, and to constitute, with its overlying Metalliferous Lime-rock (a term borrowed from Bakewell), the third or calcareous division of the Transition series. The sandstone since known as the Potsdam, which is often wanting at the base of the fossiliferous limestones in this region, was apparently unknown to him. It is here to be noted that Eaton, unlike many of his successors, did not confound these limestones, nor their stratigraphical equivalent to the east of the Hudson—the Sparry Lime-rock —with the crystalline limestone of Western Massachusetts, but recognized the fact that this, the Primitive Lime-rock, together

with the Primitive Quartz-rock and the Transition Argillite, and the great Transition Graywacke, were all alike wanting in the Adirondack region between the gneisses, constituting the lowest member of the Primitive, and the fossiliferous limestones, the highest member of the Transition series.

§ 4. Above this last he recognized a third, or Lower Secondary series, having, like the others, for its inferior member an Argillite or Graywacke-slate, and for its second or silicious member a sandstone and conglomerate. These two members were by Eaton united under the name of the Second Graywacke, which he declared to be lithologically very much like the First or Transition Graywacke, but distinguishable therefrom by the fact that it is above instead of below the Transition limestones, and is, moreover, overlaid, in its turn, by the Lower Secondary limestones. These comprised the Geodiferous Lime-rock and the Corniferous or Cherty Lime-rock, with its included layers of what he called "stratified horn-rock," in which two subdivisions we at once recognize the Niagara and Upper Helderberg limestones of James Hall. In each of these triple series Eaton recognized, in ascending order, an argillaceous or schistose, a silicious, and a calcareous member.

All of the above details of his classification may be gathered from Eaton's "Geological and Agricultural Survey of the Erie Canal" (1824), and in the second edition of his "Geological Textbook" (1832). They were set forth by the present writer, in 1878, in his volume on Azoic Rocks ("Report E of Second Geological Survey of Pennsylvania"); and more fully, with a tabular view, in an essay on "The Taconic Question," in the first and second volumes of the "Transactions of the Royal Society of Canada," in 1883 and 1884, which is reprinted, with considerable additions, in his "Mineral Physiology and Physiography" (pages 517–686) in 1886. The student who follows the painful history of the half-century of controversy which has been required to bring order out of the confusion in which his immediate successors involved this great problem of American geognosy, can only regard with reverence the wonderful insight by which Amos Eaton was enabled, at this early period, to comprehend the complex stratigraphy of the Hudson and Champlain valleys and the western slope of the Atlantic belt.

§ 5. When, a few years later, in 1837, a systematic geological

survey of the State of New York was begun, W. W. Mather was charged with the Southern district, including the region east of the Hudson, while to Ebenezer Emmons, a pupil of Eaton, was given the Northern district, to the west of Lake Champlain; Conrad, and after him Lardner Vanuxem, having the Central or intermediate district, including the counties of Oswego, Oneida, Herkimer, and Montgomery, and extending southeastward along the valley of the Mohawk to the Southern district.

Along the base of the Adirondacks, Emmons now found, in some parts, between the Transition Lime-rock of Eaton and the underlying Primitive crystalline schists, a granular or compact quartzite, which he called the Potsdam sandstone. For the rest, he did no more than confirm the determinations of his master, retaining the Birdseye or Encrinal Lime-rock of the latter as a subdivision of the Metalliferous Lime-rock, to the upper and lower portions of which he gave the names of Trenton and Chazy; while in the succeeding Second Graywacke he recognized as subdivisions, the Utica slate, the Loraine shale, the Gray or Oneida, and the Red or Medina sandstone, all of which, with the inclusion of the Potsdam sandstone, he called the Champlain division of the New York system. The last two members of this were, however, subsequently joined to what was called the Ontario division of the same system.

§ 6. The metamorphic hypothesis was then in fashion with some American geologists, and had already been applied by Nuttall, as early as 1822, to the rocks of Southeastern New York, the gneisses and crystalline limestones of which he supposed to have been formed by a subsequent alteration of portions of the adjacent graywacke and fossiliferous limestones. Mather, in extension of this notion, conjectured that the Primitive Quartz-rock, the Primitive Lime-rock, and the Transition Argillite of Eaton might, in like manner, be the results of an alteration of the members of the Champlain division of Emmons, excluding the upper sandstones; and in his final Report in 1843, on the Geology of the Southern district of New York, further maintained that not only the divisions of Eaton just mentioned, but the crystalline rocks in that State lying to the south and east of the Highland range, comprising Westchester and New York Counties, and embracing Manhattan Island, like the similar rocks of western New England, were "nothing more than the rocks of the Champlain di-

vision, modified greatly by metamorphic agencies and by the intrusion of granitic and trappean aggregates." The passage between the unaltered and the altered rocks was supposed to offer a gradual transition, and it was asserted that "no well-marked line of distinction can be drawn, as they blend into each other by insensible degrees of difference," or what have since been called successive "grades of metamorphism." These same notions were soon afterwards adopted by Logan for the crystalline rocks of the Atlantic belt in Canada, and for a time were extended by H. D. and W. B. Rogers to the gneisses and crystalline schists of the White Mountains.

§ 7. A similar view was also adopted for Pennsylvania by H. D. Rogers, then engaged in a geological survey of that State, who maintained with Mather that the Primitive Quartz-rock, the Primitive Lime-rock, and the Transition Argillite of Eaton, which are prolonged into Pennsylvania, were but the altered representatives of the Potsdam sandstone with the succeeding limestones and the Utica slate and Loraine shale of the Adirondack region. These silicious, calcareous, and argillaceous groups were named by him respectively the Primal, Auroral, and Matinal divisions of the palæozoic series, and were also called Nos. I., II., and III. in his notation. These he supposed to appear in a more or less metamorphosed and crystalline condition in the southeastern part of Pennsylvania; while farther westward in the State they occur in their unchanged fossiliferous condition, as in the Adirondack region, and are there conformably overlaid by the Oneida and Medina sandstones, which constitute together the Levant division, or No. IV. in the nomenclature of H. D. Rogers.

§ 8. The First Graywacke of Eaton, which in Eastern New York overlies the Transition Argillite, regarded by Mather as the altered representative of the Utica slate, was supposed by him to be the succeeding Loraine, Oneida, and Medina subdivisions. He thus denied the distinctness of the great belt which Eaton had traced from Canada, through Vermont, along the line between Massachusetts and New York, and confounded it with the lithologically similar Second Graywacke.

The areas of this First Graywacke, which in the southeastern part of Pennsylvania occur above the so-called "altered Auroral and Matinal," but below the horizon of the typical Levant or Oneida sandstone, were supposed by H. D. Rogers to be a part

of the Matinal, and were thus virtually made a part of the Second Graywacke. It is not too much to say that this denial by Mather of the existence of the First or Transition Graywacke, and the confounding of the great belt of this (which stretches from the lower St. Lawrence to the Susquehanna, and beyond) with the Second Graywacke, was a great and fatal error in the stratigraphy of the whole region, from the consequences of which American geology has not yet escaped. It was, however, a legitimate consequence of the hypothesis of regional metamorphism applied by Mather to the great underlying series consisting, in descending order, of the Transition Argillite, the Primitive Limerock, and the Primitive Quartz-rock of Eaton, and of his attempt to identify these with the members of the Champlain division.

§ 9. Rocks belonging to the Second Graywacke are indeed found upon the banks of the Hudson River, and Mather had already, in his fourth annual report, given the name of Hudson slates to what he rightly regarded as the equivalent of those named Loraine shale by Emmons, and Pulaski shales by Vanuxem, in their respective districts. The latter, however, noticed in the Central district of New York besides these shales (which, in its northwest portion, are directly overlaid by the Gray or Oneida sandstone) an underlying series of greenish argillites and sandstones, including some graptolitic shales, but destitute of the fauna of the upper division. The lower, named by him the Frankfort division, appear in the southeast part of the district without the overlying Pulaski or Loraine division, the two being, according to Vanuxem, "not co-extensive with each other," and so distinct that he insisted on treating them separately, inclining to the opinion that they ought not to be put together in local geology. He further declared that they are separate in Pennsylvania, the characteristic Pulaski shales appearing in the Nippenose valley west of the Susquehanna, while the Frankfort slates and sandstones are seen to the east of the North Mountain in the Kittatinny or Appalachian valley, and include the roofing-slates of the Delaware. These rocks in the latter region are, in fact, the Transition Argillite and the First Graywacke, which latter is there seen, in some localities, resting upon the roofing-slates, though in many others, in the absence of this First Graywacke, the same Argillite is directly overlaid by the Levant sandstone of the Second Graywacke.

Vanuxem, having in view the contradiction between the opinions of Eaton and Emmons on the one hand and those of Mather on the other, suggested that to the lower or Frankfort division might belong the thick masses of strata "of controverted age" along the Hudson valley. Notwithstanding the evidence put forward by him as to the distinctness of these two divisions, Vanuxem, apparently for the purpose of avoiding controversy, included both the Frankfort and the Pulaski divisions under the collective name of the "Hudson River group." That these two divisions were, moreover, supposed by him to be associated with a still older series lithologically resembling them appears from his language when he wrote of "the difficulty of separating or distinguishing the slaty and schistose members of the Hudson River group from those of greater age with which, along their eastern border, the two [divisions] are more or less, really or apparently, blended." In fact, as appears from the observations of Vanuxem in Pennsylvania, and as will be further shown elsewhere, the Hudson River group of Vanuxem included alike the Transition Argillite, the First Graywacke, and portions of the Second Graywacke. The subsequent palæontological studies of James Hall in New York for many years, however, had chiefly to do with the uppermost division of this heterogeneous assemblage, and hence the name of Hudson River group has come to be very generally regarded as synonymous with Loraine shales.

§ 10. Meanwhile, Emmons came forward as the champion of the views of Eaton, and while his field of official labor did not extend to the regions occupied by the rocks now in question, declared in his final Report on the Geology of the Northern District of New York, that some account of them was necessary to a correct understanding of the relations of the Champlain division. A curious contradiction is, however, apparent in the volume in question, in certain parts of which the views of Mather are set forth, while in others Emmons remains faithful to the teachings of his master, which he ever afterwards followed. As regards the great belt called by Eaton the First Graywacke, we find, in the account of the Champlain division, described as belonging to the Pulaski or Loraine horizon, the belt of red and purple slates with red sandstones extending "through the higher parts of Columbia, Rensselaer, and Washington Counties" in New York, "and onward through Vermont into Canada." Again, we are

told that portions of this same belt belong to the Loraine subdivision and the succeeding Gray sandstone, and that these last rocks are represented by the sandstones of Burlington and Colchester, Vermont, and also by those used in the fortifications of the city of Quebec. This whole Graywacke belt, as traced out by Eaton, is thus here referred, in accordance with the view of Mather, to the horizon of the Second Graywacke.

In another place in this same volume we find a discussion of the relations of the Transition or Sparry Lime-rock of Eaton to the Primitive Lime-rock, which in some sections apparently overlies it to the eastward, in which it is suggested that the latter may be younger rather than older than the Sparry Lime-rock.[1] This argument has lately been cited by J. D. Dana against the views maintained by Emmons in other chapters of the same volume, in which are set forth the teachings of Eaton that the Primitive Quartz-rock, the Primitive Lime-rock, and the Transition Argillite are, contrary to the hypothesis of Mather, inferior not only to the Trenton limestone, but to the whole New York palæozoic system, and are, moreover, directly overlaid by the Graywacke series in question, which is in turn succeeded by the Sparry Lime-rock. The whole of these, from the base of the Primitive Quartz-rock, are described in detail by Emmons in his volume of 1842, in chapters vii., viii., and ix., as belonging to a distinct system, for which the name of the Taconic system was then proposed. This Report of Emmons can thus be quoted against himself, as has been done by his opponents, for the passages already cited, which are introduced in other parts of the same volume, set forth the wholly opposed views of Mather as to the rocks in question. The secret history of these curious contradictions in this officially published Report on the Geology of the Northern District of New York, and of the persistent war waged alike against Ebenezer Emmons and his views and those of Amos Eaton, has yet to be written.

§ 11. These perplexing discrepancies and contradictions in the volume of 1842 were mentioned by the present writer in 1878 ("Azoic Rocks," p. 57) as probably due to want of method and to a change of views in the preparation of the work. In 1885 the dis-

[1] See for the preceding references the "Geology of the Northern or Second District of New York," by E. Emmons, 1842, pp. 121, 124, 125, 280–282, and further, p. 147.

cordances were again noticed,[1] when it was said of the volume, that Emmons therein "showed a divided opinion as to the horizon of the First Graywacke." This might be supposed to indicate the acceptance, for a time, of the views of Mather before finally adopting those of his old master, Eaton. It will, however, be noted that the passages, four or five pages in all, found intercalated in different parts of his account of the New York System, inculcating the doctrines of Mather,[2] are in complete opposition alike to the whole teaching in the three chapters—vii., viii., and ix. (pp. 135–164)—given to the Taconic System, and to his extended monograph thereon, published in 1844, so that one is led as an explanation of this strange contradiction to suppose that the passages in question may be interpolations by another hand. There is a painful resemblance in many respects between the story of Emmons and his opponents[3] and that of the warfare waged against Sedgwick by Murchison and his allies in the famous Cambrian and Silurian controversy, as set forth by the present writer in 1874 in his "Chemical and Geological Essays" (pp. 364, 365).

§ 12. The Taconic system, in the chapters just mentioned of this report of 1842, was said to include, in ascending order, the "Granular quartz" (or Primitive Quartz-rock), the "Stockbridge limestone" (or Primitive Lime-rock), and the "Magnesian slate." This latter, the Transition Argillite, comprehended, besides the characteristic roofing-slate, a great mass of soft and more or less schistose rocks, which, from the prevalence in them of hydrous micas (and occasionally of chlorites), have an unctuous character,

[1] Mineral Physiology and Physiography, pp. 522, 583, 584, 587.

[2] Loc. cit., pp. 121, 124, 125, 147, 279, 282.

[3] In a letter from Emmons to Marcou, dated Raleigh, N. C., December 29, 1860, he writes, "I made and published with my Report a modified map of the State, which showed the extent of the Taconic rocks in New York. The three thousand copies were stolen or destroyed by persons unknown, so that they were never issued with the proper volume. The rocks illustrating the Taconic system in the State Cabinet were all taken out, by order. . . . My existence as one of the State geologists was ignored at the last meeting of the American Association for the Advancement of Science in Albany [1851]. In fine, the persecution I suffered for opinion has rarely been equalled. . . . The editor of the *American Journal of Science* refused to publish my remarks upon Logan's report when he [Logan] announced his Huronian system, though their tenor was courteous in the extreme. I claimed that the Huronian was only the Taconic system." (Marcou on the Taconic System, 1885, Proc. Amer. Acad. Science, xii. 188.)

supposed to indicate the presence of magnesian silicates. Besides the three above named, there were, according to Emmons, two other divisions, the "Sparry limestone," by which he designated the Sparry Lime-rock of Eaton, and the "Taconic slate." This latter, which he declared to be quite distinct from the Magnesian slate, had, according to Emmons, been traced one hundred and fifty or two hundred miles, and included another band of roofing-slates. It is said to be more or less interstratified with limestones, and "often becomes a coarse graywacke." This Taconic slate, thus defined by Emmons in 1842 as the uppermost member of his "Taconic system," is, as will be seen, the First or Transition Graywacke series of Eaton.

Emmons, moreover, at this time calls attention to the fact that the Primitive Lime-rock, or Stockbridge limestone, "being often sparry, and of fine texture, is mistaken for the true Sparry limestone." He further remarks that as the succession of these disturbed strata is "unsettled, or at least not so clearly established as desirable," he follows their geographical order in describing them, but proceeds to tell us that the "Taconic slate" group lies between the so-called Hudson River or Loraine rocks on the west and the Sparry limestone on the east, and, moreover, that "it is undoubtedly overlapped by the former rocks, and passes beneath the latter with a dip of 30°–35°." The whole Taconic system was further described by him at this time as "the rocks lying between the upper members of the Champlain group and the Hoosic Mountains," and was, moreover, regarded "as inferior to the Potsdam sandstone, or as having been deposited at an earlier date than the lowest member of the New York Transition system."[1] The precise relations of this Transition system to the Silurian and Cambrian systems of the British geologists, and indeed the limits of these in England, were not at that date clearly understood; but Emmons, in 1842, supposed that the Taconic rocks in part might "be equivalent to the Lower Cambrian of Sedgwick," "*the upper portion being the lower part of the Silurian system*," to which the Middle and Upper Cambrian were then, on the authority of Murchison, very generally referred. That he accepted the extreme views of Barrande, and the pretensions of Murchison as to the downward extension of the limits of the Silurian, is shown by the language of Emmons, quoted farther on.

[1] Loc. cit., pp. 140, 144, 163.

§ 13. Meanwhile, Emmons continued his studies, and in 1844 published his monograph on the Taconic system, which was in 1846 republished in his "Agriculture of New York," where it forms Chapter V. (pp. 45–112). Therein, while giving a more detailed account of the Taconic system, he made one important and significant change. In 1842, while maintaining that the upper portion of this is "the lower part of the Silurian system," he had nevertheless supposed that the whole succession was deposited before the time of the lithologically dissimilar Champlain division, which, although the base of the New York system, was not by him regarded as the base of the Silurian. In this he was at variance with the teachings of Eaton, who already, as early as 1832, had declared the Transition or Sparry Lime-rock—which he placed at the summit of the Transition Graywacke or Taconic slate group—to be the stratigraphical equivalent of the Calciferous Sand-rock of the New York Transition system. Emmons had, previous to 1846, concluded that the formation of limestones of this sparry type "occurred at intervals during the whole period of the deposition of the Taconic slate," and, acquiescing in the judgment of Eaton, now declared that the upper portion of the Taconic system,—namely, the great belt of slates with limestones, sandstones, and conglomerates,—designated by him in 1842 as the Taconic slate, and including both the Transition Graywacke and the Sparry Lime-rock of Eaton, was the stratigraphical equivalent of the lower part of the Champlain division, and in fact a thickened and modified form of the Calciferous Sand-rock, which was now said to be, in its eastern extension, "protean" in its character, and to include a great variety of rocks.

§ 14. For the better identification of this Taconic slate group it is important to note that Emmons, who had already, in 1842, clearly defined its eastern and western limits in New York, and declared that it had been traced north and south a distance of one hundred and fifty or two hundred miles, repeats with detail, in 1844, the facts of its distribution. It is described as occupying geographically the interval between the overlying Loraine shales,—the upper part of the Champlain division,—on the west, and "the great mass of the Sparry limestone," which forms its eastern border, and itself lies at the western base of the Taconic Hills; which are made up of the three lower members of the Taconic system. He now adds that "the Taconic slate, with its subor-

dinate beds, occupies almost the whole of Columbia, Rensselaer, and Washington Counties, and is of immense thickness." He describes it "from Lansingburgh to the Sparry limestone on the east" as having a breadth of at least twenty miles, and, while signalizing repetitions in the section, still supposes that its volume "exceeds that of all the members of the New York system put together," adding that, "without doubt, this immense rock admits of subdivision." He declares that in the breadth of fifteen or twenty miles across this belt "the observer will pass several times over the same beds, which are brought to the surface by successive uplifts."

The nature of the uplifts by which these subdivisions of the Taconic slate group are thus repeated is further shown by an ideal section, afterwards published in his "American Geology," ii. 48. The real order of succession, as then defined, was, at the base, greenish, chloritic-looking sandstones, followed, upwards, by a great variety of different colored slates, sandstones, and conglomerates, including, moreover, what is designated as sparry limestone, black shaly limestone, and, at the summit, fine black slates.

(To be continued.)

HISTORY OF GARDEN VEGETABLES.

BY E. LEWIS STURTEVANT, A.M., M.D.[1]

(Continued from page 59.)

ARACACHA. *Aracacha esculenta* De C.

THIS South American plant is yet included among garden vegetables by Vilmorin. It was introduced to notice in Europe in 1829 and again in 1846, but trials in England, France, and Switzerland were unsuccessful[2] in obtaining eatable roots.[3] It was grown near New York in 1825,[4] and at Baltimore in 1828 or 1829,[5] but was found to be worthless. Lately introduced to India, it is now fairly established there, and Mr. Morris[6] considers it a most valuable plant-food, becoming more palatable and de-

[1] Director of the New York Agricultural Experiment Station, Geneva.
[2] Heuze, Les Pl. Alim., ii. 509.
[3] Decaisne & Naudin, Man., iv. 137.
[4] N. Eng. Farmer, July 22, 1825.
[5] Farmers' Library, 1847, 94.
[6] Gard. Chron., July 10, 1886, 50.

sirable the longer it is used. It is generally cultivated[1] in Venezuela, New Granada, and Ecuador, and in the temperate regions of these countries it is preferred to the potato. The first account which reached Europe concerning this plant was published in the "Annals of Botany," vol. i., about 1805. It was, however, mentioned in a few words by Alcedo in his "Diccionario Geographico de las Indias Occidentales ó America," 1789.[2]

The synonymy has been given as below:

Arazacha xanthoriza. Banc. Koen. Ann., i. 400.
Conium aracacha. Hook, Exot. Fl. Bot., 152.
Aracacha esculenta. De C., Prod., iv. 244.

Artichoke. *Cynara scolymus* Lin.

The artichoke, *Cynara scolymus* L., is supposed by authors to have originated from the cardoon, *Cynara cardunculus* L., and the cardoon is indigenous at Madeira, the Canaries, Morocco, the Iberian Peninsula, the south of France, Italy, Greece, and the islands of the Mediterranean. It has become naturalized on a vast scale in Buenos Ayres and Chili.[3] It is now grown on a large scale in France and other portions of Europe for the flower-heads, the scales and buttons of which make a very palatable vegetable, and in America in private gardens.

The number of varieties of artichoke is extremely large, as through the cross-fertilization of the flowers the plants do not come true from seed, and hence desirable selections are propagated by dividing the stools, or from suckers. Vilmorin[4] describes thirteen varieties as sufficiently prominent for notice.

Whether the artichoke was cultivated by the ancients is in dispute among commentators, and Targioni-Tozzetti,[5] a most competent authority, says it was only known to the Romans in the shape of the cardoon, and that the first record of the artichoke cultivated for the sake of the receptacle of the flowers was at Naples in the beginning or the middle of the fifteenth century; it was thence carried to Florence in 1466, and at Vienna, Ermolao Barbaro, who died as late as 1493, only knew of a single plant grown as a novelty in a private garden, although it soon

[1] De Candolle, Orig. des Pl. Cult., 32. [2] Don, Gard. Dict., iii. 378.
[3] De Candolle, Orig. des Pl. Cult., 73.
[4] Vilmorin, Les Pl. Pot., 1883, 14; The Veg. Gard., 1885, 3.
[5] Targioni-Tozzetti, Hort. Trans., 1854, 143.

after became a staple article of food over a great part of the peninsula. It seems quite certain that no descriptions I can find in Dioscorides and Theophrastus among the Greeks, nor in Columella, Palladius, and Pliny among the Romans, but that can with better grace be referred to the cardoon than to the artichoke. To the writers of the sixteenth century the artichoke and its uses were well known. "Le Jardinier Solitaire," an anonymous work published in 1612, recommends three varieties for the garden.

The most prominent distinction between the plants, as grown in the garden, is the presence or absence of spines. Although J. Bauhin,[1] in 1651, says that seed from the same plant may produce both sorts, and I have verified the observation, yet I cannot but believe that this comes from the cross-fertilization between the kinds, and that this absence or presence of spines is a true distinction. Tragus describes both forms in 1552, as do the majority of succeeding writers.

The form of the heads form a second division, the conical-headed and the globe.

I. The *Conical-headed.* Of the varieties sufficiently described by Vilmorin, four belong to this class, and they are all spiny. This form seems to constitute the *French artichoke* of English writers. The following synonymy seems justifiable:

Scolymus. Trag., 1552, 866, *cum ic.*

Carduus, vulgo Carciofi. I. Matth., 1558, 322.

Carduus aculeatus. Cam. Epit., 1586, 438, *cum ic.;* Matth., ed. of 1598, 496, *cum ic.*

Thistle, or Prickly Artichoke. Lyte's Dod., 1586, 603.

Cinara sylvestris. Ger., 1597, 291, fig.

Carduus sive Scolymus sativus, spinosus. J. Bauhin, 1651, iii. 48, *cum ic.*

Artichokes, Violet. Quintyne, 1693, 187; 1704, 178.

Conical-headed Green French. Mawe, 1778.

French Artichoke. Mill. Dict., 1807; Am. Gard. Books, 1806, 1819, 1828, 1832, etc.

Vert de Provence. Vilm., 1883, 16.

De Roscoff. Vilm., l. c.

De Saint Laud oblong. Vilm., l. c.

Sucre de Genes. Vilm., l. c.

Etc.

[1] J. Bauhin, Hist., 1651, iii. 48.

II. The *Globular-headed.* To this form belong two of Vilmorin's varieties, and various other varieties as described by other parties. The synonymy which seems to apply is:

Scolymus. Fuch., 1542, 792, *cum ic.*

Cardui alterum genus. Tragus, 1552, 866.

Carduus, vulgo Carciofi. II. Matth., 1558, 322.

Carduus non aculeatus. Cam. Epit., 1586, 437, *cum ic.;* Matth., 1598, 497, *cum ic.*

Right Artichoke. Lyte's Dod., 1586, 603.

Cinara maxima ex Anglia delata. Lob. ic., 1591, ii. 3.

Cinara maxima alba. Gerarde, 1597, 991, fig.

Cinara maxima anglica. Gerarde, l. c.

Green or White. Quintyne, 1593, 187; 1704, 178.

Red. Quintyne, l. c.

Globular-headed Red Dutch. Mawe, 1778.

Globe Artichoke. Mill. Dict., 1807; Am. Gard. Books, 1806, 1819, 1828, etc.

Gros vert de Laon. Vilm. 1883.

Violet de Provence. Vilm., l. c.

Etc.

In growing five of Vilmorin's varieties from seed, variability was such that we had nearly as many varieties as plants, and among other sorts had one which in its head was precisely the *Cinara major Boloniensis* of the "Hortus Eystettensis,"[1] 1613; and another, which was the *Cinara seu Artischoche vulgatiss.* of the same.

The color of the heads also found mention in the early writers. In our first division, the French, the green is mentioned by Tragus in 1552, by Mawe in 1778, and by "Miller's Dictionary" in 1807; the purple by Quintyne in 1693. In the Globe class the white is named by Gerarde in 1597, and by Quintyne in 1693; and the Red by Gerarde in 1597, by Quintyne in 1693, and by Mawe in 1778; and Parkinson, in 1629, names the red and the white.

The so-called wild plants of the herbalists seem to offer like variations to those we have noted in the cultivated forms, but the difficulty of identification renders it inexpedient to state a fixed conclusion. The heads are certainly no larger now than they were two hundred and fifty years ago, for the "Hortus Eystetten-

[1] Hortus Eystet., 1713. Aut. ord., 4, fol. 5.

sis" figures one fifteen inches in diameter. The long period during which the larger part of the present varieties have been known seems to justify the belief that modern origination has not been frequent. "Le Jardinier Solitaire," 1612, describes early varieties,—le Blanc, le Rouge, and le Violet; Worlidge, in 1683, says there are several kinds, and he names the tender and the hardy sort. McMahan names the French and two varieties of the Globe in America in 1806; "L'Hort. Français," 1824, names the Blanc, Rouge, Violet, and the Gros vert de Laon; Petit, "Nouv. Dict. du Jard.," 1826, adds Sucre de Genes to the list; Noisette, in 1829, adds the Camus of Brittany.

The name given by Ruellius[1] to the artichoke in France, in 1536, is *articols*, from the Italian *articoclos*. He says it comes from *arcocum* of the Ligurians, *cocali* signifying the cone of the pine. The Romans call it *carchiophos*, and the plant and the name came to France from Italy. The names I have seen assigned are in alphabetical order: Arabs, *kharchiof*, *hirshuf*,[2] *raxos*, *harxos*;[3] Berber, *taga*;[4] Egypt, *charsjuf*;[2] Flanders, *artisjok*;[5] France, *carciophe*,[6] *artichaut*;[3] Germany, *strobildorn*,[7] *artischoke*;[5] Hindustanee, *kunjir*;[2] Holland, *artisjok*;[5] India, *kunjeer*, *ateechuk*;[8] Italy, *carciofo*, *articiocca*,[5] *archichiocco*;[6] Persia, *kunjir*;[2] Portugal, *alcachofra*;[5] Spain, *alcachofa*,[5] *cardo de conner*.[9]

Asparagus. *Asparagus officinalis* L.

The cultivated asparagus seems to have been unknown to the Greeks of the time of Theophrastus and Dioscorides, and the word *asparagos* seems to have been used for the wild plant of another species. The Romans of the time of Cato, about 200 B.C., knew it well, and Cato's[9] directions for culture would answer fairly well for the gardeners of to-day, except that he recommends starting with the seed of the wild plant, and this seems good evidence that the wild and the cultivated forms were then of the same type as they are to-day. Columella,[10] in the first century, recommends transplanting the young roots from a seed-bed, and devotes quite a space to their after-treatment, and he offers

[1] Ruellius, De Stirp., 1536, 644.
[2] Birdwood, Veg. Prod. of Bomb., 165.
[3] Dalechamp, Hist., 1587, ii. 1436.
[4] De Candolle, Orig. des Pl. Cult., 74.
[5] Vilmorin, Les Pl. Pot., 14.
[6] Cast. Durante, 1617, 91.
[7] Tragus, 1552, 866.
[8] Speede, Ind. Handb. of Gard., 164.
[9] Cato, c. 161, c. 6.
[10] Columella, lib. xi. c. 3.

choice of cultivated seed or that from the wild plant, without indicating preference. Pliny,[1] who wrote also in the first century of our era, says that asparagus, of all the plants of the garden, receives the most praiseworthy care, and also praises the good quality of the kind that grows wild in the island of Nesidis, near the coast of Campania. In his praise of gardens[2] he says, "Silvestres fecerat natura corrudas, ut quisque demeteret passim; ecce altiles spectantur asparagi; et Ravenna ternos libris rependit." (Nature has made the asparagus wild, so that any one may gather as found. Behold, the highly-manured asparagus may be seen at Ravenna weighing three pounds.) This evidences the likeness remarked between the wild and the cultivated form, and the recognition of the change produced by culture. Palladius,[3] an author of the third century, rather praises the sweetness of the wild form found growing among the rocks, and recommends the transplanting to such places otherwise worthless for agriculture, but he also gives full directions for garden culture with as much care as did Cato. Gesner[4] quotes Pomponius, who lived in the second century, as saying that there are two kinds, the garden and the wild asparagus, and the wild asparagus the more pleasant to eat.

The word Asparagus, as used by the Romans, meant the cultivated form, the word *Corruda* the wild plant. The original meaning seems to have been a succulent shoot, for in this sense it was frequently used by the Greek writers. In the European languages we have the continuance of the word under various forms, as *Sperage* by Turner, 1538; *Asparagus* by Gerarde, 1597 and to date, as also *Sparrowgrass*. In Denmark, *Asparges;* in France, *Asperge* or *Esparge* in 1586; in Germany, *Epargen* in 1586, *Epargel* in 1807, and *Spargel* at the present time; in Greece, *Asparaggia;* in Holland, *Aspergie* in 1807, *Aspersie* now; in Italy, *Asparagus* in 1586, and *Sparagio* at present; in Portugal, *Espargo;* in Russia, *Sparsa* or *Sparsch;* in Spain, *Asparrago* and *Esparrago;* and in Sweden, *Sparis* or *Spargel*.[5]

In extra-European languages the following names appear: By the Moors, *halion* or *helium*, Cam. Epit., 1586; in Arabic, *yer-*

[1] Pliny, lib. xix. c. 42.
[2] Ib., c. 19.
[3] Palladius, lib. iii. c. 24; lib. iv. c. 9.
[4] Scriptores Rei Rust., 1788, Lexicon, art. Asparagus.
[5] See Miller's Dict., 1807; Camerarius, Epit., 1586; Vilmorin, Les Pl. Pot., 1883.

amya, *marchoobeh*;[1] in India, *marchooba*, *nagdoon*, or *asfuraj*;[2] Hindustanee, *hilyoon*, *nagdoun*;[1] in Persian, *margeesh*;[1] in Japan, *kikak kosi*;[3] in the Mauritius, *asperge*.[4]

The expression of Parkinson, 1629, "a delectable sallet-herbe," implies the consideration in which for many centuries it has been held. Its culture in Italy was, as we have seen, quite general in ancient times. We have no records of its first appearance in the various countries of Europe, but it is mentioned in England by Turner in 1538, and as under cultivation by Gerarde in 1597. In France[5] it was well known in 1529. In America "*Sparagus*" is mentioned in Virginia in 1648,[6] and in Alabama in 1775,[7] and in 1785 Cutter mentions asparagus as if it was then a well-known vegetable in Massachusetts.

The wild plant is indigenous to Europe; as an escape from gardens it is often noted in America, not only in waste places on the coast, as Gray states, but also inland. There are no essential points of difference between the wild and cultivated forms; such as are noted between the escapes and the garden plants are only such as come from protected culture and rich soil; the figures in the ancient botanies do not indicate other variation than this, and the few varieties, so called, of our gardens have no especial importance, the differences being but in minor points, and but indicative of a careful selection and high culture, the ordinary variability of a variety furnishing plants which are propagated by division.

The point I wish to make regarding this vegetable is this, that although under high cultivation now for over two thousand years, under diverse climates and treatment, yet it has remained constant to type. The directions given by the Roman writers to plant the seed of the wild plant might be followed to-day with our escapes without detriment. It has given no variety types that have been recorded from the time of Cato up to this present year of grace. Where, then, is this boasted power of man by which he is supposed to modify our wild plants into improved types? It probably does not exist. The types of our cultivated plants have been apparently taken from nature, as produced by

[1] Birdwood, Veg. Prod. of Bomb., 187.
[2] Speede, Ind. Handb. of Gard., 1542, 160.
[3] Thunberg, Japan, 139.
[4] Bojer, Hort. Maur., 1837, 350.
[5] Ruellius, Dioscorides, 1529, 124.
[6] A Perfect Desc. of Va., 1649, 4.
[7] Roman's Nat. Hist. of Fla., i. 115.

the slow process of natural selection, and the influence of selection and diverse cultivations has been but to secure variation within the type limits, and such variations are usually of the character which may be described as expansion under culture, or its opposite; as smoothness and regularity of form; as enhanced quality.

Asparagus Bean. *Dolichos sesquipedalis* L.

This bean was described by Linnæus[1] in 1763, and I find no record of an earlier notice. It reached England in 1781.[2] Linnæus gives its habitat as America, and Jacquin received it from the West Indies. Martens[3] considers it as a synonyme of *Dolichos sinensis* L. Loureiro's description of *D. sinensis* certainly applies well to the asparagus bean, and Loureiro[4] observes that he thinks the *D. sesquipedalis* of Linnæus the same. He refers to Rumphius's "Amboina," l. 9, c. 22, tab. 134, as representing his plant, and this work, published in 1750, antedates the description of Linnæus. I think this is probably an East Indian plant, introduced to the West Indies, but I am unable from my notes to present the varieties and the forms which have been included under *D. chinensis*.

The name of Asparagus bean comes from the use of the green pods as a vegetable, served as a string-bean, and a tender asparagus-like dish it is. The name at Naples of *Fagiolo e maccarone* conveys the same idea. The pods grow very long, oftentimes are two feet in length, and hence the name of *Yard-long* often used.

The *Asparagus* or *Yard-long bean* is mentioned for American gardens in 1828,[5] and probably was introduced earlier. It is mentioned for French gardens under the name of *Haricot asperge* in 1829.[6] There are no varieties known to our seedsmen, but Vilmorin offers one, the *Dolique de Cuba*.[7]

The names under which it is known are: in France, *dolique asperge, haricot asperge;* in Germany, *Americanische riesen-spargel Bohne:* in Holland, *Indianische boon;* in Italy, *fagiuolo spara-*

[1] Linnæus, Sp. 1763, 1019.
[2] Miller's Dict., 1807.
[3] Martens, Die Gartenbohnen, 100.
[4] Loureiro, Fl. Cochinch., 1790, 436.
[5] Fessenden, New Am. Gard., 1828.
[6] Noisette, Man. du Jard., 1829.
[7] Thorburn's Seed Cat., 1828.

gio,[1] *fasoi longhi, fagiolo e maccarone*;[2] at Cayenne, *pois rubran*;[2] at Barbadoes, *Halifax pea*;[3] at Jamaica, *asparagus bean*;[4] in Cochin China, *dau dau* and *tau co*.[5]

(To be continued.)

THE EAST GREENLANDERS.

BY JOHN MURDOCH.

THE veteran authority on the Eskimos, Dr. Rink, has recently published an able and interesting paper on this easternmost outpost of the great Eskimo race,[6] in which he reviews the ethnological results of the late successful Danish expedition to East Greenland under Captain Holm, and draws important conclusions as to the original home of the Eskimos, and the probable course of the wanderings by which they have reached their present habitations.

In his opinion, the metropolis of the Eskimos is probably to be found in Alaska, and he finds a confirmation of this view in the fact that here the Eskimos are not confined to the coast, but spread inland along the rivers.

It is a fact, however, that the proportion of the Eskimos of Alaska who really dwell in the interior is very small indeed, being confined to the valleys of the Kuskokwim and the adjoining less important rivers, and to the three rivers emptying into Kotzebue Sound, while along the rest of the coast from Kadiak to Point Barrow they are as purely littoral—or "Orarian," to adapt Mr. Dall's term—as in Greenland or Labrador. Nevertheless, this scanty remnant may represent the original condition of the race.

He believes that the migrations of the race can be traced by the development of certain inventions as we pass along the shores of the continent from Alaska to Greenland. For instance, the kayak, which is probably, as he believes, derived from the open

[1] Vilmorin, Les Pl. Pot., 280. [2] Martens, l. c. [3] Schomburgkh, Hist. of Barb. [4] Macfadyen, Jam., i. 288. [5] Loureiro, l. c.

[6] Die Ostgrönländer in ihrem Verhältnisse zu den übrigen Eskimostämmen. Von H. Rink. Deutsche geographische Blätter, vol. ix. No. 3, 1886, pp. 228–239.

birch canoe, still used by the Eskimos of the Upper Kuskokwim, is far heavier and more clumsy in the west than in the intermediate regions, and reaches its highest development in Greenland.

It is, however, to be noted that the kayaks in use along the shores of the Arctic Ocean from Bering Strait to Point Barrow are far superior to those used by the nearest Eskimos to the eastward of that point, and approach closely in lightness and elegance to those of the Greenlanders, though essentially different in model.

According to our author, the use of the double-bladed paddle among the true Eskimos (excluding the Aleuts) does not begin till we reach the mouth of the Yukon, and is only used when speed is specially desired, even as far as Point Barrow, while a single-bladed paddle is sometimes used in the kayak as far as the Mackenzie. Moreover, the art of turning completely over in the kayak and righting oneself by means of the paddle is very unusual on the Alaskan coast, and completely developed only in Greenland.

A similar course of development, Dr. Rink believes, may be traced in the set of weapons with which the kayak is fitted out. He considers the "bird-dart" and "bladder-dart" (the former a javelin with a cluster of prongs at the middle of the shaft for taking fowls in the water, and the latter designed for catching seals, and therefore provided with an inflated bladder to impede the motions of the wounded animal) to be developments of the arrow, and the large harpoon, with a bladder attached by a line, to be a development of the latter, and finds the more primitive forms of these weapons more generally used in the south and west, while the more highly-developed forms gradually appear as we approach Greenland.

Our extensive collections at the National Museum tend to confirm these conclusions. The larger part of the harpoons from the region south of Bering Strait, even those of large size for capturing the beluga, are of the type of the "bladder-dart," or of the still more simple type without a bladder, in which the shaft itself is made to act as a drag by attaching the line to it in a martingale, and these, especially to the southward, are often feathered like arrows. Even as far as Point Barrow the only projectile weapons used in the kayak are the bird-dart and a small "martingale-dart."

The custom of wearing the labrets, or peculiar lip-studs of the western coast, which extends as far as the Mackenzie region, is believed by Dr. Rink to be a custom which the wandering Eskimos brought with them from their original homes, when they were in contact with the labret-wearing Tlinkets.

On this supposition, however, it is difficult to account for the abrupt way in which a custom universal up to Cape Bathurst ceases at that point, without a vestige of it traceable anywhere to the eastward. When we consider that there is now a long stretch of uninhabited country between the natives of Cape Bathurst and their neighbors in the east, with whom they have no communication, is it not more probable that the labret-wearing habit is one of comparatively recent date, which, spreading from the south and west, only reached the Mackenzie region after communication with the east was severed?

Dr. Rink derives a similar argument from the dwellings of the Eskimos, which in Southern Alaska resemble those of the Indians, having a fireplace in the middle of the floor.

As we go north and east the fireplace is replaced by the oil-lamp, and snow-huts gradually take the place of houses, till in Greenland we find edifices of earth or turf and stones and drift-wood. The form of the house also changes from square or round to an oblong shape in Greenland, capable of being added to at the ends in proportion to the number of the household. This extension reaches its greatest development in East Greenland, where the whole village occupies a single house.

These large dwelling-houses also furnish a substitute for the large public club-houses, for working, and social and religious assemblies, so common among the Eskimos and also usual among the Indians. Such houses as these are no longer found in Greenland, if they ever existed there, and are but partially represented among the eastern Eskimos by a sort of large snow-houses. The periodical festivals and masked dances, so frequent in the west, are less frequently practised as we approach Greenland, apparently in proportion as the influence of the *angokoks*, or wizards, increases.

The greatest similarity between the branches of the race is to be seen in the language. According to Dr. Rink, the number of "radical words," or those which form the basis of the intricate compounds used in the language, which differ from the Green-

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landic or are doubtful in the other dialects, may be roughly stated in percentages, from the material at his command, as follows: in the Labrador dialect, fifteen per cent.; in the middle regions, twenty per cent.; in the Mackenzie region, thirty-one per cent.; and in Alaska, fifty-three per cent. A careful study of the vocabulary collected by our expedition (U. S. International Polar Expedition to Point Barrow, Alaska), containing over one thousand words, in which about five hundred and fifty radicals may be distinguished, has convinced me that only fifteen per cent. of these are different from the Greenlandic radicals.

There is no doubt, as our author believes, that the inhabitants of East Greeland and Alaska, brought together and allowed sufficient time, could easily learn to understand each other. In fact, the interpreters from Labrador who accompanied the English explorers had no difficulty in conversing with the western nations, and I have seen American whalemen, who had made themselves familiar with the Eskimo jargon in use at Hudson's Bay, converse fluently with the natives of Point Barrow.

Dr. Rink believes that the dialectic differences indicate that the Aleuts were first separated from the parent stock, then, and much later, the Southern and Northern Alaskan Eskimos, those of the Mackenzie, and finally those of the middle region, and that Labrador and Greenland were peopled by branches from the last.

Coming, now, to the consideration of the peculiarities of the newly-discovered East Greenlanders, he considers them in much the same condition as their western neighbors when described by Egede. One noticeable peculiarity about their harpoon is mentioned,—namely, that the head is fastened to the shaft by a pivot, as in the "toggle-iron" used by civilized whalemen, whereas among all other Eskimos the head slips off the shaft and "toggles" at right angles to the line. The harpoon-float is made of two bladders instead of one, and the old implements for taking seals on the ice, abandoned on the west coast since the introduction of firearms, are still in general use.

The bow is no longer used, owing to the disappearance of the reindeer, but cross-bows are used as toys by the children, or for shooting birds. The knowledge of this weapon, the writer believes, is due to foreign influence. They have no fish-hooks, but take fish with the net or a three-pronged spear like those used by the Eskimos in many other regions.

Their artistic taste and skill is very great, and equals, or even excels, that of the long-famous Alaskan Eskimos. Their carvings often consist of little figures carved from bone or ivory, fastened with pegs to wooden surfaces. All sorts of implements are ornamented with such carvings, representing natural and imaginary objects or conventionalized ornaments. The most extraordinary of their objects of art are the relief maps carved in wood, in which the islands are represented by separate pieces, attached to the mainland by thongs.

Much taste is also exhibited by the women in ornamenting and embroidering their clothing (in which, again, they resemble the Alaskan Eskimos), though their needles are all home-made, hammered and ground out of old iron obtained from wrecks.

The inhabitants of each winter village appear to form one large household, more or less under the control of a single head, chosen apparently by tacit consent, and whose commands often do not need to be expressed. The head of the household was observed to give definite commands as to the order in which the eight families of his household should take their places on the sleeping platform, how the lamps should be lighted and the windows closed. During the winter one young man was expelled from the house by way of punishment, and compelled to seek shelter elsewhere. Hospitality is universal, as with the Eskimos everywhere.

The largest of the several "village-houses" on the Argmagsalik fjord, where Captain Holm wintered, contained fifty-eight people. The house nearest Captain Holm's winter-quarters had eight families, thirty-eight souls living and performing all their work, sleeping, cooking, eating, singing, and dancing in a space twenty-seven feet long, fourteen and a half feet wide, and at the utmost six and a half feet high!

Much valuable linguistic material was collected, thanks to their excellent interpreters, Christian West Greenlanders, and fifty-one interesting traditions, of which thirteen are plainly identical with those of other Eskimos, while in thirteen others are recognizable well-known traditional elements. From a preliminary examination of the linguistic material, it appears that there is more difference between the dialects of East and West Greenland than between the well-known North and South Greenland dialects.

Captain Holm is of the opinion that the East Greenlanders

travelled round Greenland from the north, while the West Greenlanders came down southward along the shores of Baffin's Bay, meeting the others at the southern point of Greenland, and there forming a mixed race. The author considers that the differences described favor this hypothesis, but thinks it too early to draw a general conclusion from the facts at hand. He adds that the mixed race in all probability also contains Scandinavian elements, though not the slightest trace of Scandinavian culture is to be discovered.

In a foot-note at the beginning of the article Dr. Rink states that the direct inspiration of the paper was the fact that he had the opportunity of studying the rich ethnological collection from East Greenland in company with Captain Holm, and also personally received information about the western Eskimos from the brothers Krause and A. Jakobson, and about those of the middle region from Dr. F. Boas. He also courteously acknowledges the information received from other sources, especially from those in America who are engaged in studying similar subjects.

U. S. NATIONAL MUSEUM.

THE SIGNIFICANCE OF SEX.

BY JULIUS NELSON.

(Continued from page 42.)

EXPLANATION OF PLATES VI.—VIII.

Figs. 94 to 124, *h*, illustrate cell-division (94–104 are Protozoan), and Figs. 124, *j*,–133 illustrate fertilization (*i.e.*, the union of male and female pronuclei).

PLATE VI.

FIG. 94, *a–b. Opalina ranarum*—Kent, Plate 26. See also Nussbaum, A. m. A., xxvi., and Zeller, Z. w. Z., xxix.—This "unicellular" animal is multinucleate, and the nuclei multiply by karyokinesis (see Figs. 104, 105) independently of cell-division. The latter takes place successively as in *a*, until small cells like *b* result, containing few nuclei. These become encysted and the nuclei fuse to become one. Then the mononucleate animal escapes and increases in size, while the nuclei become more numerous again. Their number may rise to hundreds.

FIG. 95, *a–d. Oxytricha scutellum*—Gruber, Z. w. Z., xl.—As this infusorian grows the number of nuclei increases by direct division until we have a form like *c*, then the nuclei fuse (*d*) to become one, and then once more divide. As this proceeds the cell-body is constricted between the groups of nuclei as shown in *a* and *b*.

FIG. 96, *a–b. Polycricus schwartzii*—Bütschli, A. m. A., ix.—This infusorian

PLATE VI.

94 a
b
95 a
b
c
d
96 a
b
97 a
b
c
d
97½ a
b
108
98 a
b
c
d
e
f
g
99 a
b
c
100 a
b
c
d
101
a
b
c
d
e
107
102 a
b
c
110
103
a
b
c
d
e
f
g
h
j
k
l
m
n
o
p
q
104 a
b
c
105 a
b
c
d
e
f
109
g
h
j
106 a
b
c
d

usually has a row of four nuclei as in *a*, but when division takes place the nuclei divide so as to furnish the daughters with the normal number (*b*).

FIG. 97, *a–d. Stylonychia histrio*—Nussbaum, A. m. A., xxvi.—Here we have two sorts of nuclei, a small spindle-shaped "paranucleus," which in division presents the spindle-fibres and microsomata of karyokinesis, and a large nucleus whose "nuclein" substance is more irregularly distributed. In a resting state (*a*) the paranucleus is homogeneous and nearly spherical, the nucleus has small bodies in it that resemble the paranucleus. When cell-division takes place (*b*, *c*) both sorts of nuclei divide so that the daughter-cells are multinucleate, but when these return to the "resting" condition the nuclei fuse once more, as seen in *d*. Here the nuclein bodies of the nucleus are drawn out into filaments.

FIG. 97½, *a–b*. Represents division of *Paramœcium*,—from article "Protozoa" in Encyclopæd. Brit., by Lankester. Here the paranucleus divides into two groups of four each, but the nucleus divides up much finer and strongly suggests beaded filaments. Bütschli in A. m. A., ix., figures the nucleus as broken up more irregularly.

FIG. 98, *a–g. Polytoma uvella* (*a–c*, *f–g*) and *Dallingeria drysdali* (*d* and *e*) —Dallinger, Jour. R. Micr. Soc., April, 1886.—After conjugation (see Fig. 131) the fertilized nucleus of the monad is dissolved throughout the protoplasm in ultra microscopic particles (gemmules), and when the cyst bursts these are projected out, and soon grow so as to be visible to a power of fifteen thousand diameters, until finally they attain the size and shape seen in *a*, then granules appear in their substance, and at the same time a clear zone of protoplasm (*b*) is secreted about this body, which henceforth is the nucleus (*c*). When division is to take place the granules arrange themselves in regular lines as in *d*, and a peculiar and simple karyokinesis follows (*c–f*), with return of granules to normal distribution in *g*, a daughter-nucleus.

FIG. 99, *a–c*. Nucleus of *Chromulina woroniana*—Fisch, Z. w. Z., xlii.—The wall of the nucleus is thick and contains nuclein, but there is also a nucleolus which segments up into fine granules, while simple constriction of the nucleus ensues (*a–c*), and when the daughter-nuclei are established, these granules fuse and return by inverse kinesis to the normal state.

FIG. 100, *a–d*. Nucleus of *Cyathomonas truncata*—Fisch, l. c.—This is thin-walled, and most all the chromatin is in the nucleoli. In *a* four of these bodies are seen. In *b* we see rows of granules raying out from the nucleolus, and the nucleus and nucleolus behave in division much as if the former were a cell and the latter its nucleus; finally, after division (*c–d*), the rays disappear, and we get a simple nucleus with a nucleolus.

FIG. 101, *a–e*. Nucleus of *Cordosiga botrytis*—Fisch, l. c.—We have first a clear vesicle containing a nucleolus, the latter gradually dissolves into granules (*a*, *b*), and the granules fuse to filaments (*d*), which arrange themselves parallel to one another like a spindle, and then the fibre-bundle constricts, followed by the nucleus (*e*). The original state is assumed by the daughter-nuclei passing through an inverse series of changes: thus from *e* we get successively *d*, *c*, *b*, *a*, etc.

FIG. 102, *a–b*. *Onychodactylus acrobates*—Entz, Mitt. Neap., v.; *c*, *Stylonychia mytilus*—Bütschli (from Kent, Plate l.).—Division of nucleus and paranucleus during cell-multiplication. The nucleus and paranucleus remain closely applied to each other; the latter *leads* in division. The segments of the former remain united by a bridge (*c*), the centre one only being severed by cell-division as in *b*.

FIG. 103, *a–q*.—*a–c*. Nucleus of *Spirochona gemmipara*—Hertwig, Jenaische Zeitschrift, xi. *d–q* is a nucleus of *Actinosphærium eichornii*—Hertwig, Z. z., xviii.; see Gruber, Z. w. Z., xxxviii.—*a–c* show the amœboid powers of nuclear substance;

in *a* the phenomena are restricted to the nucleus; in *b* to the hyaline body which holds the nucleolus, and at last, in *c*, the nucleolus is sending out ray-like pseudopodia, which become the chromatin fibrils. A spindle is finally formed with a hyaline end-plate at each end. *d–h* show different states of a nucleus in the "resting" condition. In *d* we have a nucleolus and paranucleolus; these segment and become related, as in *e* and *f*. In *g* the nucleolus is much segmented. *h* shows us the nucleus preparing for division; the special protoplasm sheet lining the nucleus is amœboid, as is also the nucleolus. The former, at last, gathers as two polar caps (*j*), while the latter dissolves to granules (*k*); at first the granules are in the centre of the nucleus, then they pervade its whole substance, and finally a peripheral clear zone is established (*k*). The substance of this zone then moves to the poles, forming a "polar plate," while the granules aggregate in vertical lines, and fuse more and more towards the equator to form an equatorial plate of microsomata (*l*). Then segmentation begins again, and the daughter-microsomata move apart towards the poles (*m*). On their way they form a continuous plate or zone of very minute granules (*n*), but sometimes the groups may be shown to be still distinct, as at *o*, which also shows the polar *stars* ("asters") raying out from the protoplasmic cap. The microsomata are received and absorbed by the polar plate in a rosette-like figure (*p*). The polar plate invaginates like a gastrula, while the spindle constricts; the polar masses of protoplasm flow down on the sides (*q*), and are at last themselves constricted to serve as an envelope for the daughter-nuclei; the spindle-fibres are absorbed into the cavity of the gastrula-like "calotte," and a stage-like *h* results. The substance of these fibrils is probably that which is separated from the nucleolus to form the paranucleolus.

FIG. 104, *a–c*. A nucleus of *Opalina ranarum*—Nussbaum, A. m. A., xxvi.—The nucleus divides by first forming four "microsomata nucleoli," seen in polar view in *a*. These microsomata divide and move along fibres to the poles, as in *b*, and simple constriction, as in *c*, and reversion to uninuclear condition follows.

105, *a–j*. A nucleus of *Opalina ranarum*. According to Pfitzner (M. J., xi.), *a* shows an irregular reticulum or "knäuel" with a couple of nucleoli and irregular masses of chromatin at the surface. In *b* the chromatin has become aggregated in superficial microsomata. These are forms of resting nuclei. The initial condition from which division proceeds is seen in *c*. We have an abundant knäuel and a few nucleoli; then in *d* the knäuel (skein) filament segments; next, in *e*, the segments are concentrated to the centre. The nucleoli may or may not be absorbed. Now there ray out fibres from an "amphiaster" towards the centre from two opposite points, and the segments of nuclein arrange themselves into an equatorial plate (*f*), and, splitting each into two, send the regular number of V-shaped loops along the fibres of the spindle to the poles (*g*, *h*). Constriction follows (*j*), and the segments once more fuse into a "skein-filament" or a "reticulum." This gives us as complicated a form of karyokinesis as we find in the cells of metazoa.

FIG. 106, *a–d*. Nucleus of embryonic cells of *Scorpion*—Blochmann, M. J., x.—To show "direct" division A nucleolus is built up from *a* to *b*; the nucleolus then divides, next the nucleus does so, and at last the cell constricts according to the Remakian scheme.

FIG. 107. Nucleus of *Vorticella* in division—Carnoy, p. 217.—Shows a simple constriction without modification of the net-work.

FIG. 108. Epithelium nucleus from gut of *Astacus*—Frenzel, Mitt. Neap., v.—No karyokinesis during division, though we have a reticulum and nucleoli.

FIG. 109. Male ovum of *Pelobates fuscus*—Carnoy, p. 40.—Cell and nucleus suffer

PLATE VII.

111
a
b
c
d
ε
f
g
h
j
k
112
114
113
115
116
117
118
119
dy
dz
fw
fx
fy
fz
120
121

simple constriction; the segments of the nucleolus are thus separated without a spindle,—a mode of division known as "stenosis."

FIG. 110. Nucleus of muscle-fibre of larva of *Hydrophilus* (Carnoy, p. 240) entering into division. The segments of the nuclein filament are seen lying among the fibres of the spindle, which latter have been transformed from the karyoplasmic network.

PLATE VII.

FIG. 111, *a–k*. Nucleus from cells of endoderm of Cœlenterates except (*k*) which is ectodermal—Pfitzner, A. m. A., xxii.—*a* gives the "skein" reticulum; *b* shows the skein-filament segmented, while the nucleolus has divided. In *c* we get the segments in centre; in *d* the nucleoli have dissolved; in *e* the polar asters have formed a spindle, and the segments have formed a "rosette" in its equator; *f* shows the "rosette" broken up into loops by segmentation of outer limbs of the rosette. This is the "monaster" stage, and when the loops have split and duplicated themselves we get in *g* the "dyaster." *h* shows the spindle with the loops near the poles and with astral rays streaming out into the cytoplasm; *j* shows the constriction of spindle and of cell; in *k* we have a true skein-filament that does not form a reticulum.

The formation of the cell "plate," where (as in plants) there is no cell constriction, may be seen in Figs. 124, *h* and *s*, and modern text-books on botany.

FIG. 112, *a–g*. Karyokinesis from epithelium of *Salamander*—Flemming, A. m. A., xviii.—*c*, *d* are from testes as seen in living state. Here we see bodies at the poles nearly corresponding in number to the segments of the filament. When the dyaster is formed they are about twice as numerous, and strongly suggest that they are a species of paranucleolus. *cf.* 97½, 103, etc. In the daughter-nuclei the series *a*, *b*, is inversely followed, as in *e*, *f*, *g*. In *g* the filament is cut across by the knife in many of its windings, thus giving us pseudo-nucleoli.

FIG. 113, *a–g*. Epithelium of *Salamander* according to Rabl, M. J., x.—*a* is a schematic side view, and *b* a polar view of a resting nucleus. According to Rabl the segments of the filament do not fuse or in any way anastomose in the resting nucleus, but simply branch out finer and finer. Then in kinesis the branches are withdrawn, and short thickish loops are formed. The spindle is first seen in its entirety at one pole, which, as seen in *a* and *b*, is different from the other pole, and then the spindle turns at an angle of 90° and forms the usual amphiaster (*c*, *d*). When the loops split, the halves are carried apart at their *bend* first, and the shorter arms of the U are first separated as seen in *e*. Arriving at the poles the loops branch out once more, as in *f*, to form the figure *a*. In *g* we see a daughter-nucleus from testicular epithelium of Proteus, where the branching does not take place, but the loops are formed of a row of microsomata (beaded filament).

FIG. 114, *a–b*, shows how such a beaded filament splits by each microsoma dividing in the general plane of the loop. Pfitzner, M. J., vii.

FIG. 115, *a–e*. Nucleus from growing point of *Tradescantia virginica*—Strasburger, "Zellbildung u. Zelltheilung," Jena, 1880.—The nearly homogeneous protoplasm of the nucleus (*a*) becomes granular; the granules fuse and arrange themselves in rows of microsomata (*b*), and these rows are cut across (*c*) in the equator and pushed towards the poles while undergoing various changes of segmentation back to granules again, but a central nucleolus remains undissolved, or rather is built up during the process of reconstruction of the daughter-nucleus (*d*, *e*).

FIG. 116, *a–e*. Nucleus of *Spirogyra majuscula*—Strasburger, l. c.—In *a* we see the lenticular nucleus with its nucleolus; *b* is a face view showing it becoming granular. In *c* the nuclein has segmented (or aggregated?) into more and more numerous masses

or microsomata which soon reach the granular state again (*c*, *d*, *e*). Meanwhile the nucleus flattens more and becomes biconcave; the granular protoplasm gathers in the concavities and sends across and through the nucleus the spindle-fibres (*e*); the marked boundary of the nucleus is dissolved, and the equatorial plate of granules splits and moves towards and into the polar masses, while the intervening portions of the spindle-fibres ("connecting fibrils") spread out and help build the cell-plate.

FIG. 117 is from *Spirogyra nitida*, where the nucleus is more spherical and the spindle-fibres are at first aggregated towards the centre in union with the central granular mass of chromatin, and they become more spread out as the nucleus loses in outline and the chromatin is divided into its daughter portions. We see also that the latter is confined to the central fibres of the spindle.

FIG. 118, *a–dz*. Nuclei from protoplasmic layer next wall of embryo-sac of *Galanthus nivalis*—Strasburger, A. m. A., xxiii.—*a*, first step towards karyokinesis; the microsomata form a continuous beaded filament, produced by the shortening of a finely-wound "skein" or "tangle," the meshes of whose reticulum give a finely granular appearance to the protoplasm. A large nucleolus exists besides. This is dissolving and adding itself to the filament in *b*, where the boundaries between the microsomata are not indicated in the diagram. *c* is the "segmented stage," in which we have on both sides of the equator segments whose equatorial ends are bending around like hooks (only a few segments are shown). Next, the hooks split longitudinally, and the halves of each hook seek opposite poles; to do this there must be a stage where one-half of the loops of the southern hemisphere cross the equator and meet corresponding hooks from the northern on their way to the southern hemisphere. (See *d*, where *w* and *w'* are the corresponding halves of the southern hooks, and *x* and *x'* of the northern hooks. *w'* and *x'* are represented as having just crossed.) While this "metakinesis" is progressing the hooks become more U-shaped, and taking the northern daughter-nucleus, as in *dy*, we can see how its skein-filament is reconstituted in *dz*, by union of neighboring limbs of the sets of loops. (Metakinesis refers to the changes that take place after the splitting of the loops or microsomata to form the chromatin figures which are to occupy the daughter-nuclei. The preceding changes constitute the "prophase," the succeeding, the "anaphase.")

FIG. 119, *a–l*. From wall of embryo-sac of *Fritillaria imperialis*—Strasburger, A. m. A., xxiii.—*a–d* represent the prophase, *e–f*, the metaphase, *g–l*, the anaphase. Here the first step of the metaphase is, as in the last case, one of mutual transfer between the opposite sides of the equator. (See *f*.) Following any one loop in the northern hemisphere, splitting into two halves (1, 2, Fig. *fw*), the part 2 is destined for the northern daughter-nucleus, and 1 for the southern. Separation between the two halves proceeds from one end to the other, so that the part 1 becomes pulled out straight, one limb of the part 2 is held back, while the other is dragged towards its own pole (*fx*), both halves are therefore acted on so as to be pulled into line parallel with a meridian, but the end, as it approaches the pole, bends around hook-shaped to form a new loop, hence the part 2 passes through an "S" stage (*fy*), and the part 1 a hook stage, and they finally reach the U stage in *fz*, when the stages *dy* and *dz* ensue, as in the preceding figure. On comparing Figs. *f–l*, it will be seen that practically this mathematical regularity is never attained, but only distantly approximated. The number of loops in Strasburger's figures is far greater than in the diagram, but they may be deciphered and understood by means of the diagrams (Fig. *f–fz*). The main source of departure is found in the fact that most of the loops are not perfect U's in the anaphase, but are oftener hooks or even straight filaments lying in the meridians. In the last case *fw* and *fx* would be omitted.

PLATE VIII.

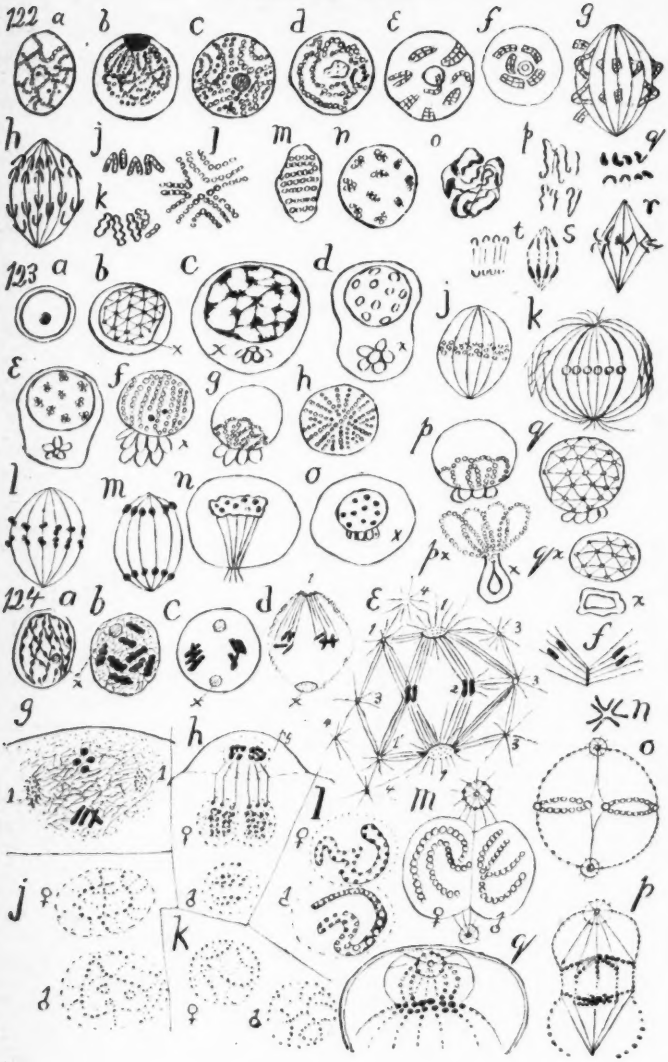

FIG. 120. Cell from testis of *Chelonia caja*—Carnoy, p. 250.—The nuclear spindle is nearly constricted off in the equator; the cytoplasm is partly so, and shows its fibres as regularly arranged as those of the spindle.

FIG. 121. Dividing sperm-cells from *Rat*—Weidersperg, A. m. A., xxv.—The two cells are at a distance from each other, but still the spindle-fibres unite the two daughter-nuclei.

PLATE VIII.

FIG. 122, *a–t*. From pollen mother-cells of *Fritillaria persica*—Strasburger, A. m. A., xxiii.—*a–g* is the prophase, *h–m* the anaphase, *m–r* a succeeding prophase, and *r–t* the next anaphase. The filament is at first much finer and more intricately woven than represented in the first three diagrams. In *b* we see a nucleolus at one pole in connection with which the loops of the skein are put; *c* is a polar view of the same. In *d* the filament has shortened more and passed out of its relation with the polar nucleolus, which is now breaking down. Next, in *e*, the segmentation is completed, and the limbs of the U-shaped segments are closely applied to each other; then, in *f*, these stumpy "loops" get crowded into the centre, and the spindle is formed (*g*). Then splitting ensues and metakinesis (*h*). In the daughter-nuclei the loops come to lie so as to make the poles of the nucleus unlike: side view in *j* and *k* and polar view in *l*, where the open ends of the loops point towards the old equator. Finally the daughter-nucleus is constituted as in *m* and *n* side and surface (polar) views respectively. But as it is about to divide again, the return to the resting state is not complete, immediately a continuous filament is established, with local thickenings on it, showing the chromatin already segmenting. While segmentation proceeds, the segments get into the meridians and shorten towards the equator (*p* and *q*), then the spindle is formed (*r*), and after the anaphase straight rods of chromatin pass to the poles, where they curve into loops (*s*, *t*). This series shows what variability there may be between successive divisions of same nucleus. Such variability has also been reported by the next (Fig. 123) and Carnoy (Fig. 124).

FIG. 123, *a–qx*. Spermatogenesis of *Helix pomatia*.—*a*, the nucleus, with a thin layer of protoplasm about it, forming the "sperm mother-cell." It is now homogeneous, soon becomes granular, and a reticulum is developed (*b*). Out of the nucleus now buds a paranucleus (*x*). Then there is a period of growth until we get *c*, with a rich surface reticulum of chromatin. In *d* the meshes of the reticulum have been absorbed by the karyosomata. In *e* each karyosoma has by binary segmentation formed four microsomata; these re-establish the net-work by separating to equidistant distribution, and, by retracting the connecting processes in some directions and strengthening them in a meridional direction, they form a series of loops of a filament (*f*). The paranucleus now approaches the pole, and at the same time the loops contract towards it, forming a rosette (*g*). The outer turns of the rosette break, as seen in polar view given in *h*. The paranucleus is absorbed, and the loops with their bends towards the axis move down to the equator (*j*); at the same time the spindle is formed. Here each loop shortens into a single karyosoma, forming fourteen to twenty such bodies in an "equatorial plate (*k*); the fibres of the spindle are in union, by means of the rays of the polar aster, with the cytoplasmic reticulum. Each karysoma now segments again into four microsomata (*l*), but only the first plane passed in the meridian cuts through completely; the second is simply the beginning of an attempt to form a beaded filament. These short filaments, consisting each of a pair of microsomata, now pass through the metaphase; but on their way the microsomata fuse to form the karyosomata of the daughter-nuclei (*m*, *n*). The spindle-fibres are utilized

in forming the paranucleus (see A. m. A., xxvi.), the karyosomata segment to form the rosette *p* and *px*, where *p* is the figure in the first division and *px* that of the last. The reticulum is again established in *q* and *qx*; the steps following the final division are shown in Fig. 81, *a*, *b*, *c*, etc.

FIG. 124, *a–s*. "Cytodieresis" of the egg of *Ascaris megalocephala* (*a–g*), from Carnoy—La Cellule, vol. ii., May, 1886. *h–s* from Van Beneden, A. B., iv.—*a* is the nucleus of a young egg having a beaded filament forming a "skein." There is besides a nucleolus which Carnoy calls a "plasmatic-nucleolus" (*x*). Soon the filament segments (*b*) into eight karyosomata, and then the reticulum of the nucleus can be seen remaining. The egg grows, and when mature, and containing the spermatozoon, the preparations for forming the polar globules are made. The poles of the egg become marked each by a plasmatic-nucleolus; and the eight karyosomata now take an equatorial position in two groups (*c*), which gives to the germinal vesicle the appearance of having two germinal spots when viewed with moderate powers. The next stage shows the reticulum and wall of the germinal vesicle dissolved (which solution appears with all nuclei at this stage). Two groups of fibres now ray down from one pole towards the karyosomata (*d*). The other half of the spindle is soon completed in a similar manner. Then from the poles, where is a granular mass called a "plateau," there ray out into the protoplasm, fibres to form primary asters (1). The plateaux may split and so form several secondary plateaux, one of which is shown at 1′, Fig. *e*, for each pole, but its aster is still primary, because a part of its rays enter into the nuclear spindle. There may be several of these formed by repeated splitting of the "plateau." Secondary asters (2) are formed when the streamers flow from the karyosomata. Tertiary asters (3) are those connected with primary asters, but not a part of nuclear spindle; while quatenary asters (4) are small asters scattered through the yelk, but they may be connected with any other aster by one or two filaments. These asters are simply transformation of the ordinary reticulum, and no fixed law governs their production, and the utmost variety of combination may be found. The system of asters is much more complex in the formation of the second polar globule than in the first. Our description of Fig. *e* is from the second "caryocinetique figure." The asters finally fade out until only one plateau with its bilateral spindle is left; this often closes up on itself (*f*), so that the polar plate looks like an equatorial plate; the karyosomata are thus carried around into a plane at right angles to their old position, and tend to approach each other. But this mode of disappearance of the asters is only one of several. The last trace of the spindles and asters disappears (*g*), the plateaux are reduced to granular spots, the reticulum of the plasma is restored, but not as yet the membrane of the nucleus. Now the reticulum produces a simple spindle anew (the "spindle of separation") between the two groups of karyosomata, and the most peripheral one is cut off by an equatorial cell-plate, much as in plants (*h*). The segment cut off, which sometimes contains part of the yelk, is the polar globule. Then the four karyosomata of the yelk separate into groups of two each, and the process is elaborately repeated, so that only two karyosomata are left in the yelk to form the female pronucleus. The karyosomata in the polar globules may divide by karyokinesis. After the last polar globule has been extruded (*k*) the two karyosomata of the female pronucleus segment up into microsomata, and a similar figure is seen with the nuclein of the male pronucleus. *j* shows the two in a stage where a beaded filament is being established by concentration and shortening; *k* is a further stage; *l* shows the filament splitting in each pronucleus, but each first segments transversely into two; the pronuclei are closely applied to each other in a bilateral way, as seen by the position of the polar asters, which now appear (*m*). The loops

finally arrange themselves in the equator, so as to show in polar view as in *n*; two of these loops were furnished by the male and two by the female. A side-view of this stage is shown in *o*, where the filaments have split in the middle, but not yet at the ends and the centre. In *p* the V-shaped loops have diverged towards the poles quite a ways; the central apices, however, move faster towards the poles than the outer limbs. *g* shows the microsomata somewhat irregularly segregated at the base of a figure formed by the polar aster and spindle of conducting fibre, and at the apex of the spindle of connecting fibrils, which is now constructing the cell-plate as in *s*. This seems to show that the *connecting fibres* and the *conducting fibres* belong to distinct systems, which is more clearly shown in *r*, where the karyosomata are placed at the cross-points of the meshes formed by the interlacing of the two systems. In the construction of the daughter-nucleus the microsomata pass by segmentation into a knäuel like that seen in *j* and *k*, and only when the equatorial plate is again formed for subsequent division do we get the four loops once more established, as is seen respectively at the left and right of *s*. Van Beneden, however, ignores the evidence of his own figures, and states that the four loops remain distinct throughout. (See text for further discussion.)

(*c*) KARYOKINESIS.

TWO extreme types of cell-division are known; in one, the nucleus simply constricts into two halves that move apart, followed by a similar constriction of the cell-body, so that each of the daughter-cells is provided with its own nucleus; in the other type the nucleus undergoes changes by which it becomes invisible to the microscope, unless the cell be treated with proper reagents, and as the partition which divides the cell-body appears, there is gradually built up a nucleus in each of the daughter-cells. The former type is known as *direct division*, the latter as *indirect division*. The term *karyokinesis* (nuclear motion) is usually restricted to the latter kind of division, but we are learning that there are many forms of indirect division that gradually unite the two extremes, so that we can no longer make the above distinction. The term karyokinesis admits readily of a broad signification, and we shall use the word as including all sorts of nuclear transformations.

Our knowledge of cell-structure and of the nucleus has wonderfully increased since 1833, when *Robert Brown* discovered the nucleus while studying the generative organs of orchids, and *Von Mohl* (1835) first saw it divide. To-day we are making as rapid progress in this direction as ever, and there is no field of biological research which offers so great inducements to the investigator, or so valuable results as this.

In all our progress there has been but one tendency, and that is to show us that the cell, and especially the nucleus, is a com-

plex and highly-organized structure. We can no longer use the term *protoplasm* in its old sense of *one definite substance* whose remarkable properties are due to the great chemical complexity of its molecule.

1. *Historical.*—In the works of *Schleiden and Schwann* (1838–1840), which established the cell-doctrine, the cell was described as originating by the activity of the *cytoblast* (the nucleus), which was itself due to a condensation of granules in the cell-substance of the mother-cell. The endogenous origin of cells and cell-nuclei was, however, gradually overthrown, and in 1855 Remak established the generalization that all cells are due to the division of pre-existing cells in such manner that the nucleolus first divides, then the nucleus, and lastly the cell-body. This schema could rest only on the facts of direct division and a superficial observation of indirect division. As soon as the latter was carefully studied by *Hoffmeister*, in 1867, he found that the nucleus disappears and two centres of attraction arise in the cell, in connection with which the daughter-nuclei were built up. These facts had been observed in animal-cells already in 1858, by *Munk*, so that the view that a cell must return to a cytode condition to divide and so, in a manner, be rejuvenated, and produce new nuclei endogenously, was fairly established. This school was strengthened by receiving the support of all who had observed the maturation of the ovum (except Warneck, 1850), for here it was seen that the germinal vesicle disappears before segmentation, and that the nuclei of the segmentation products arise as new structures, and, moreover, *Valette St. George* had, in 1866, shown that the ovum is a cell, the germinal vesicle a nucleus, and the germinal dot a nucleolus.

The complex nature of cell-structure was surmised by *Brücke* as early as 1861, although the microscope had then only revealed granules, and that these were at times arranged in a radiate manner with reference to the nuclei.

In 1865, *Frommann*, through extended research, described the reticulate nature of protoplasm and generalized that this was the typical structure of protoplasm, but his views remained for many years unnoticed.

In 1873, *Heitzmann* advocated the view that whenever a protoplasmic mass was fully developed it became vacuolated, and so showed a reticulated structure in which the nodal points ap-

peared as granules. The nucleus is only a large nodal point in the centre, and as this developed it repeated the process, and finally the nucleolus in a mature cell takes on the reticulate structure. He laid the basis for Nägeli's theory of heredity by advancing the notion that the reticuli of all the cells in the body are continuous, and so anticipated modern studies of protoplasmic continuity.

This year is memorable as marking the beginning of studies on karyokinesis. The stimulus came from a paper by *Schneider*,[1] in which the different phases were pretty well described, though their connection and sequence were unknown. Even the spindle and cell plate were figured. *Bütschli* and *Fol* confirmed these results, the former mainly as to the nuclear rosette and its separation into two halves to constitute the daughter-nuclei, while the latter got the asters and spindle best; hence the former agreed with Schneider that there was no deconstitution of the nucleus, while the latter inclined to side with the orthodox school.

Auerbach now appeared with his "Organologische Studien" (1874). He starts with Heitzmann's views as to the organization of protoplasm, but considers the nucleus to be a sap-cavity into which molecules of protoplasm wander and grow to become nucleoli. These multiply by division, so that old cells have many nucleoli. The cells of highly-organized tissues, he says, have more nucleoli than cells lower in the scale of organization. The nucleoli are young cells, and they are simply separated into two groups in direct division; but in indirect division, which he distinguishes as *palingenetic*, these are dissolved into a molecular state in the nuclear sap, and then absorbed with the sap by the cell-plasma. This process is termed *karyolysis*, the spindle with its polar asters is the karyolytic figure and the simple expression of the streaming out of the nuclear substance. Later, near each star, the sap and molecules return to form a daughter-nucleus. This seemed a pretty fair explanation, and *Flemming* at this time was much influenced by it.

Bütschli, however (1875), opposed the theory, though he modified his former view of the simple persistence and division of the nucleus to the view that the nucleus is *reconstructed* into a spindle, at whose equator the fibres become thickened to form the nuclear plate, which plate by splitting passed it's halves to the poles of the spindle to be re-formed into nuclei. In the same

[1] A list of the papers referred to will be given at the close of the article.

year the first edition of *Strasburger's* work on cell-division appeared. This treated in the main of the plant-cell, where the spindle thickenings after separating leave between themselves connecting fibrils that are more prominent than in the animal-cell. These he called *nuclear fibrils*, and at their equator a second set of thickenings appear that go to construct the dividing wall between the new cells, hence he named it the *cell-plate*. The second edition of this work appeared in 1876, and the third in 1880. In the last he changes the name he gave the connecting fibres to *cell-fibres*, because he supposed that they were formed from the cytoplasm penetrating into the nuclear matter at the time of the deconstitution of the latter.

Van Beneden, on the other hand, agreed with Bütschli that the spindle comes from the old nucleus. He distinguishes between the nuclear *sap* and the *nuclear essence*. The connecting fibrils are of the same essence as the nuclear disk, and are due to the drawing out of the elements as they segment into the daughter-disks.

In this year, also, *Hertwig* showed that the egg-nucleus does not disappear during cleavage, but passes through a metamorphosis similar to the cell-divisions described by Bütschli. At the poles of the spindle and in the centre of each aster he finds a *polar corpuscle*. Fol had seen corpuscles in the stars, but had confounded them with the daughter-nuclei. The following year, 1876, Fol corrects this error. *Balbiani* found the nuclear plate to be composed of *rod-like elements* that were composed of *granules*, but these views were unnoticed, so that *Pfitzner* received the honor of their discovery five years later.

At this time the elements which compose the nuclear plate were not distinguished from the spindle-fibres, due to the fact that reagents which made the one visible left the other obscure, hence there was a good deal of contradiction in the results, which was unreal.

In this year *Bütschli's* chief work appears. He supposes the infusorian nucleus to represent the original type of nucleus. He thinks the cytoplasm stimulates the nucleus to division, though it may not itself necessarily follow the example. The rays of the stars are not the expression of attractive forces of the nucleus, but are rather due to a chemical influence. He found that the asters when they first appear near the nucleus, are not necessarily at opposite poles. R. Hertwig had divided the nuclear mat-

ter, like Van Beneden, into sap and nuclear substance, *Strasburger* now proposes the following scheme. There are in the nucleus three formed substances, one of which is active. By the excitation of the cytoplasm the active substance gathers at the poles of the nucleus, leaving the spindle-fibres stretching between; the latter are cytoplasmic in origin, and the polar substance acts on them just as it acts on the fibres of the cytoplasm which form the stars, hence the general disposition of the polarized molecules in rows radiating away from the polar area. The third substance is first repelled from the poles to form the nuclear equatorial plate; but in some way there is a change of polarity by which it is subsequently attracted to the poles, and so the plate splits in two (it might also do this through internal repulsion, but, as we shall show farther on, there is no necessity for a physical explanation). This is perhaps the best of the few theories which have been advanced to account for the phenomena.[1]

On the question of the solution of the nucleus, *Fol* now took a middle ground, holding with Strasburger that the cytoplasm entering formed the spindle, but the nuclear matter simply became continuous with the cytoplasm through the dissolution of the nuclear membrane.

In 1878, *Schleicher* advanced the view that the protoplasm was composed not of parts that had a fixed relation to one another, but of units that were independently mobile, and so all the structures were amœboid in form, hence there could be no definite phases during cell-division, wherefore he proposed the term *karyokinesis* to designate the phenomena. On the other hand, *Flemming* had, by careful staining, worked out the series of forms through which the nuclear matter passes during karyokinesis. He did not get the spindle well because, as he showed the next year, this was composed of non-stainable matter. The resting nucleus consists of a vesicle enclosing a reticulum and one or more nucleoli. This reticulum is changed to an exceedingly long and intricately wound filament, at the same time the nucleoli dissolve in the sap and the filament absorbs the material. This is the phase of the *close knäuel.* (Fig. 112, *a.*) The filament now shortens and grows thicker, passing through the open

[1] We give the theory in its most developed form, third edition of Strasburger's work, 1880, where he slightly modified it from its original statement in the second edition.

knäuel stage, until it shows as a *rosette* (Fig. 111, *e*), with loops turned peripherally and towards the centre. Then the outer limbs of the loops break, leaving a lot of V-shaped filaments having their apices towards a common centre. (Fig. 105, *f*.) This is the "mother-star." Meanwhile the central point of attraction splits and moves to the poles, where asters now appear. This is accompanied by alternate expansion and contraction of the nuclear star (diastole and systole), and finally results in its flattening into an "equatorial plate" (Fig. 113, *d*); then each loop splits lengthwise, though it may have done so while still in the mother-star (Fig. 119, *e*), and thus formed the "fine-rayed star." The halves of each loop become separated and grouped in a "dyaster," or two daughter-stars, passing through the phase which shows as a splitting of the equatorial plate. Then the apices of the loops (travelling along the spindle-fibres) are drawn towards the poles (Fig. 112, *e*), drawing the limbs after them, and so reach the pole. Here they form into a figure like the old mother-star (Figs. 112, *f*, 105, *h*), and return, by uniting ends through the rosette (Fig. 118, *f*) into the knäuel form, and finally become like the mother-nucleus.

The next year Flemming divided cell-division into *direct* and *indirect*. He limited the former to motile cells, and accepted Schleicher's term as applying to the indirect kind. He thinks the nucleoli are an accidental thing in a nucleus, and according as nuclear substance stains or not he calls it *chromatin* and *achromatin*. In the same year, 1879, Fol proposed his electrolytic theory of cell-division. He believed the nuclear reticulum was directly transformed into the spindle, and the nuclear plate was due to an equatorial thickening of its fibres.

Strasburger's studies gave him different results from Flemming. In plants the phases are not so marked, but may give a spindle figure of chromatic granules arranged in rows like the staves of a cask; and the daughter-nuclei arise through the simple breaking of these across the middle. (Figs. 115, *a–d*.)

In 1881, *Retzius* had confirmed the phases of Flemming, but showed that the rosette must be given up, as segmentation of the knäuel may take place while in the loose or open knäuel stage. (Fig. 112, *b*.) He says the chromatic substance is contained in a hyaline matrix, as Pfitzner has shown, and most of it is absorbed by a particular node or nodes, and these are the nucleoli.

Pfitzner, this year, called attention to the fact that the nuclear loops are composed of granules like a row of beads, and that the loop splits by the segmentation of each granule. He thought these granules to be the protoplasmic molecules, but later (1883) said they were independent and individual units in the nuclear structure. (See Fig. 114, *a*, *b*.)

In 1882, Strasburger proposed the terms *cytoplasm*, *microsomata*, *nucleoplasm*, etc., which we adopted in Section *a* of this paper. He studied more carefully the method of rearrangement of the loops in the equatorial plate during its division, and finds that it is more complex than Flemming made it, for the old bend straightens out, and one end of the loop gets drawn towards the pole, and then bends like a hook, and this new bend travels along the filament to its middle point, thus making the two limbs equal, while at the same time the loop is drawn polewards. Strasburger had not yet discovered the splitting of the loops, so that he had as yet only an imperfect notion of how the rearrangement took place. (See Figs. 118 and 119 for the actual facts.)

In this year appeared *Flemming's* systematic work on the cell, and in it he accepts the criticisms of Retzius and Strasburger, so far as they relate to the rosette phase and the "rearrangement." He doubts if there is a reticulum in cells, or at least in nuclei. The appearance may be due to the optical effect of a closely-wound filament or *mitom*, the sap is the paramitom, and karyokinesis should be termed mitokinesis, or mitosis. Besides the mitom there are chief and accessory nucleoli. He gives up the idea that the chromatin may dissolve in the cell-sap. He gives us the term *spirem* for the knäuel phase. Rearrangement in the equatorial plate is termed *metakinesis*. He uses the term aster for the star-form of the mother-nucleus, and dyaster for that of the daughter-nucleus.

In 1883, *Pfitzner* makes three sorts of chromatic substance in the nucleus. The substance of the spindle, hitherto called achromatic, he terms *parachromatin*, while the sap only is true achromatin. The nucleolus has *prochromatin*, while the mitom has the true chromatin. In the resting nucleus there may be, besides Strasburger's membrane, which belongs to the cytoplasm, a true nuclear membrane of parachromatin.

Roux, in this year, proposes a theory of karyokinesis, based on the idea that there is a mixture of qualities in the chromatin,

etc., and that these have to be distributed in a definite way between the daughter-cells at each division. Hence the complicated machinery.

In 1884, *Rabl* seeks to show that there never is a simple filament in a cell, but that the loops pre-exist even in the resting state, and that in this latter state the chromatin flows out along definite paths into finer and finer branches, which never anastomose, but may swell up at points, where a special lot of chromatin gathers, and there form nucleoli. The cell is heteropolar, always having the apices of the loops directed towards the principal pole. (See Fig. 113, *a–f.*)

Heuser agrees with Rabl in finding the mitom segmental in the resting phase.

In this year *Strasburger* discovers the splitting phase in certain plant-tissues. (Figs. 118, 119.)

Carnoy now comes to the front with important contributions. He finds, what has not been noticed by previous observers in its true light, that there exists a true reticulum in the nucleus, like the reticulum in the cytoplasm (Fig. 4), but that the mitom in its convolutions hides this, and gives us the aspect of a coarser reticulum (Fig. 3), which is the one referred to by previous investigators. The mitom may be itself reticulated (Fig. 13), or its segments be short and rod-like in some cells (Figs. 123, 124), but besides these there are the nucleoli. All the nucleoli are not composed of true chromatin. There are one or two that are composed of *plastin* (Figs. 44, 124, *b, c*), like the true reticulum, and with it and the membrane become transformed to the achromatic or spindle part of the figure. The phases of Flemming are realized only in a limited number of cases, and there appears to be the utmost variety in the karyokinetic figures; we may get forms where the nuclear reticulum does not become transformed, although the mitom may segment. (Figs. 109, 110, *stenotic division.*) Again, the achromatic part of the figure may in one and the same cell differ under different circumstances from great complexity to simplicity of structure.[1]

Platner has also made important contributions (see Fig. 123, *a–qx*); but these will be considered in another connection.[2]

[1] See also, Lee, "Carnoy's Cell Researches." Q. J. M. S., April, 1886.

[2] The latest paper by Platner (see Bibliography) has just come to my notice. Platner thinks the spindle fibres are one continuous filament in which is a proto-

Thus we get a notion of the cell as a most varied organism. Cells may be as varied among themselves as the higher organisms. But we have hardly begun to get an idea of the variety of karyokinetic phenomena; what is to appear by future study we can only vaguely imagine. The phenomena of cell-division cannot be purely physical phenomena. They are living phenomena, and show they are subject to the laws of heredity and evolution of adaptation and variation. If this be so, we can understand karyokinesis only through comparative studies, just as we study the laws of variation and evolution, of homology and affinity with higher organisms. It becomes important, therefore, to understand karyokinetic phenomena among the Protozoa. Recent studies in this line have shown that here we may get nearly as complex figures of karyokinesis as in tissue-cells; but from this we get all grades down to the simplest direct division. We learn that nuclei may be alike in distantly-related forms, while closely-allied forms may have very diverse nuclei.

2. *Protozoa.*—These organisms present, as we should expect, a great variety of nuclear forms and karyokinesis. The differentiation has been in so many different directions, with the acquirement of secondary characters whose physiological significance we can hardly guess, that it is perhaps impossible to connect the forms. Frey thinks the vesicular form of nucleus is the primitive one, but most writers agree with R. Hertwig in deriving this form from a solid form through vacuolation of the latter, which leaves the chromatin either all in a cortical zone, or else in one or more nucleoli; and this process may be repeated in a nucleolus when this becomes large and important. Gruber suggests that in a primitive state the chromatin was present throughout the cell in a granular form, as in Trichosphærium, Pleurophrys, Trachelocercus, Chœnia, and others, and that solid nuclei arose by fusion of these granules, or by some of them remaining in close union following their multiplication. But it must be observed that this granular condition could easily arise by the segmentation of larger bodies and so be secondary in

plasmic streaming in one direction. Each meridian bears a karyosoma that splits, because the fibre splits; thus, always in a meridional plane. The parachromatic mitom is so wound that the current is towards opposite poles in neighboring fibres after the splitting, hence the daughter karyosomata are swept to their proper poles. This theory appears to be as weak as its predecessors.

character. In some forms we get either many small nuclei or else granules, besides one or more chief nuclei, and, according to Altmann, this is true of all tissue-cells, so that we have nuclear bodies first differentiated in two directions, the granules serving some nutritive or other function, while the nuclei retained the office of being the primary reproductive bodies.

The next differentiation arising would be the differentiation of the nuclei into two kinds, which in some Ciliates have acquired considerable independence and act quite differently during division. We know them as nuclei and nucleoli, or as nuclei and paranuclei, respectively. Better terms are Huxley's *endoplast* and *endoplastule*, as not implying homologies which are probably false. In massive nuclei the chromatin exists in a fine net-work, which gives the appearance of granules in the resting phase and of fibrillæ during division. In Gastrostyla the endoplastules divide by a true spindle and a nuclear plate of karyosomata. Nearly all the nuclei of Opalina are of this sort.

The substance of the nucleus may differentiate into two sorts that gather in two portions of the nucleus, either by polar differentiation or by centripetal differentiation. One substance is hyaline, the other granular; examples are Leptodiscus, Spirochona, and Noctiluca. In Spirochona it is the endoplast which has this structure, and it divides by a complex kinesis. A nucleolus appears in the clear part, which becomes transformed into fibrils while the hyaline portion gathers as two polar plates that separate, and so, as it were, tear the nucleus in two. The three endoplastules present divide by simple constriction at the same time; and here also there are polar plates of a substance different from the equatorial portion.

In a different direction we get the vesicular differentiation, and this is most common in the lower Protozoa, and is that from which the metazoan cell-nucleus is derived. In Rhizopods we may not only get many nuclei (about two hundred in Pelomyxa), but each nucleus may present a great variety of phenomena. There may be a central nucleolus, and this nucleolus may be composed of many microsomata, or the microsomata may separate as so many nucleoli, or again may fall into granules. Together with all these forms there may be a cortical shell of microsomata, for examples, see Figs. 14, *a*, *b*, 20, 22. The multinuclearity of many of the Protozoa is due to the fact that

cell-division is purely facultative, and has not been inseparably associated with nuclear division. When it takes place, as in Opalina, any number of nuclei may be separated away in the daughter-cell. In many cases the nuclear divisions affect only the chromatin, while the hyaloplasm and its nucleolemma remain as *funiculi* uniting the segments. (See Figs. 42, 31, 29, 28, 41, etc.) The microsomata of a nucleolus or of a karyosoma behave in the same way; as in Figs. 19, *d*, 43, 114, 115, 123, *g*, 124, *o*.

In Radiolaria we get a multitude of small "massive" nuclei that divide by amœboid constriction (Fig. 25), and in the central capsule vesicular nuclei, whose different metamorphoses are shown in Figs. 16, 17, 18, and 19.

In division of vesicular nuclei we get, as the simplest form, the Remakian scheme. (Fig. 100.) Next we may get the granular contents arranged in fibrils that are bisected by the constricting nucleus (Fig. 101), or they may remain in the granular state. (Fig. 99.) The most complex case is given by *Actinosphærium eichornii*. (Fig. 103, *a–q*.) Here the nucleolus separates into two bodies, one containing chromatin and one the parachromatin; then each body segments into fine granules; these granules get arranged in fibrils; the chromatin-granules fuse to karyosomata lying in an equatorial plate in the spindle formed by the parachromatin; the karyosomata divide into daughter-karyosomata that pass towards the poles; on its way each daughter-karyosoma segments to microsomata; the microsomata segment to granules, which, however, form separate karyosoma-like masses until they are absorbed by the polar plates. The latter are due to the fact that the external protoplasm had gathered at two opposite poles of the nucleus and had attracted the parachromatic cortical layer of the nucleus. Why the protoplasm should gather at the poles and so induce nuclear division is unknown. Possibly substances in the nucleus have first passed to the poles and attracted the cytoplasm. These substances may be the segments of the paranucleolus, for it is possible to derive the spindle-fibres from a differentiation of some of the chromatin-granules into hyaloplasm.

It is rare to find the nucleolus (or the granules that represent it when it is segmented) in the same condition during nuclear division as during the resting phase. There is a cycle of changes, so that one condition has to be assumed for division, and then the chromatin returns through inverse stages to its resting state.

The phases of this cycle may be few or they may be many, and besides, the phase in which the nucleus rests may be in one case in one point of this cycle, in another it is a different phase of this cycle. *But in all cases the cycle is made up of stages of fusion or of segmentation between the two extremes of one single nucleolus and of numerous granules.* (The law is unchanged even if we suppose that the granules are the nodes of a reticulum.) Usually nuclear division follows that point in the cycle where the chromatin is most condensed. Thus, even in the Remakian schema, this law is followed, as see Figs. 99, 100, 101. *Cases like Figs.* 101, 103, 104, *and karyokinesis in Metazoa are related to the Remakian schema by a compounding of the latter, for each karyosoma follows the Remakian schema.* We thus see that direct division is to indirect division as a unicellular or unisegmental animal is to one that is multicellular or multisegmented. *If we study the cell-division of multinuclear Protozoa we find that the same laws hold.* Opalina is an exception, and such forms as Polykrikos (Fig. 96), that have only nuclear division during cell-division, are connecting links to the far larger class of cases, where, as in Oxytricha (Fig. 95), Paramœcium (Fig. 97½), Stentor, etc., there is fusion of the nuclei (or of nuclear segments in moniliform endoplasts) before division and multiplication of these bodies preceding, during, or following division. In Paramœcium the resting phase concurs with the mononucleate phase. But even in the exceptions to this law there is fusion, when these forms encyst to produce spores (Fig. 97) by the successive or by simultaneous division of the fused nucleus. In such cases, as in conjugation of low forms, the phenomena may be facultative, the number of nuclei resulting from the fusion being one which varies from one to the original number, just as the resulting spores may vary in number.

What is the meaning of this? *It is evident that we have here to do with conjugative phenomena.* These self-same nuclei that with one form of cell-division fuse, may, in case of buds, be set free, as microgonidia to fertilize other gonidia. It may be that the granules and nuclei are in different parts of the cell subjected to different conditions, and thus come to vary slightly. If, now, the cell divided, the daughter-cells would differ, and ultimately new species be formed. But, as we find that if conjugation phenomena be left out in one place in the different modes of reproduction it is apt to occur in other points of the cycle, and if

prevented, as in male and female parthenogenesis, the resulting organisms are weak, we must conclude that the organism derives some benefit from the mixture of chromatins that are slightly different. In the case assumed above, where cell-division is not accompanied by fusion of the nuclei, we may presume that conjugation of gametes supplies this lack,[1] though in Opalina the only form of fertilization as yet discovered is that of nuclear fusion during encystment. But Opalina is a parasite, and parasites, we know, get along remarkably well without fertilization.

This explanation of karyokinesis seems quite plausible, so that we may formulate the law *that every cell-division is preceded by fertilization phenomena: is accompanied by close inbreeding.* Other explanations have been suggested. Strasburger regards karyokinesis as resulting in like cells, therefore the different chromatins present must be carefully divided, so that each daughter-cell shall receive its proper ingredients. Roux and Weismann go further and call attention to the fact that dividing cells are not alike, so that we need a particular distribution of the gemmules for each division, so that, to follow the last author, in the first egg-segmentation, the histogenic plasm is separated from the generative plasm. Thus the soma is descended from one blastomere and the generative cells from another. In a similar way the endoderm-cells have a common ancestor, and the ectoderm another, and so on. This explanation seems to me difficult of application to the Protozoa, so that the law enunciated above appears to be unaffected.

3. *General.*—It would extend the length of this paper unduly, as well as be of no interest except to the specialist, to discuss the various views that have been advanced in interpretation of the special stages of karyokinesis. Nevertheless, some of the more prominent features should be noticed. We have already seen that cell-division need not be necessarily associated with nuclear division, whether this be direct or indirect, so in the higher tissues there occur cells that present such conditions. These are the internodal cells of Chara, many fungi where the nuclei are granules, and the generative tissues of both plants and animals; also in cartilage-cells and marrow-cells. In the generative tissues of plants cell-division does not take place until many endosperm

[1] The formation of varieties and species must take place in spite of this tendency of differentiated chromatins to fuse.

nuclei are present, and to this form of division the term *free-cell formation* has been applied, while the term in the sense in which Schleiden used it has been pretty nearly abandoned. Still, we saw that in the Protozoa nuclei could arise by the fusion of granules, and return by fragmentation to the granular state, and it may be a question whether similar phenomena may not be found in tissue-cells. The cases of the endogenous origin of nuclei are reported in eggs that have so much yelk that it is hard to follow the nuclear changes.

Does the cytoplasm or the nucleus stimulate division? Hertwig holds that the nucleus is the automatic centre which controls the individuality of the cell, but it must be confessed that the earliest changes are in the cytoplasm. Protoplasm gathers at two points and forms stars, between which the nucleus becomes stretched out and transformed. Carnoy (Fig. 124), and lately (1886) Hertwig, have found independent stars arising in the cytoplasm, and if more than two of these get connection with the nucleus, there are as many poles and spindles or resulting daughter-nuclei as there are asters. The rays about these asters are simply a transformation of the reticulum. What their function is we can only guess with the numerous guesses made by predecessors. They may be nutritive, may be paths for travelling gemmules, may have a nervous function, or finally only serve motor functions. The spindle-fibres are a similar transformation of the nuclear reticulum (*i.e.*, the parachromatin reticulum); whether the nuclear membrane in dissolving adds to their material, or gathers at the poles of the spindle as in Actinosphærium, may be doubtful. In the latter case it would continue its original function of mediating between the intra- and the extra-nuclear reticulum. But Strasburger and others find that the astral- and spindle-fibres are continuous, and thinks the latter come by a penetration of the former through the poles of the nucleus. But the mass of evidence is against him, and besides, the spindle-fibres are composed of parachromatin (chemically, *plastin*) and react differently from the extra-nuclear fibres.

Then there are the polar corpuscles in the centres of the stars, and forming the apices of the spindle. Their origin is obscure. Possibly the plastin nucleolus of Carnoy may, by its division and migration, have initiated the division of the nucleus, and is represented in these corpuscles. It is certain that these corpuscles

may divide, and so split the spindle (Fig. 124), and often the two stars first arise close together, and move later to opposite poles. We must also notice Rabl's discovery of a spindle intact in the nucleus, which rotates into its position (see Fig. 113, *c*) through an angle of 90°.

In what condition is the chromatin in the resting nucleus? It may be present as a fine or as a coarse reticulum, closely interpenetrating the parachromatic reticulum, and perhaps fused with it. In the germinal vesicle it is present as a nucleus, which becomes transformed into the reticulum before division. The next change this reticulum suffers is its transformation into a mitom,—*i.e.*, a filament,—which, while it is very long and closely balled up, may not be distinguished from a reticulum. Some nuclei rest in this phase, or in subsequent phases of its shortening and consequent thickening. When thick it has been found to be composed of granules that fuse to form microsomata, so that finally the mitom is one microsoma thick. The next phase is one in which the mitom segments into loops or filamentous karyosomata. Some cells rest in this phase. (See Fig. 124.) When the segmentation occurs early, while the reticulum is being transformed into the mitom, we get a condition of things represented in Figs. 113 and 45. The karyosomata are apt to be short or corpuscular in generative cells. (See Figs. 122 and 123.)

Now we have two ways in which the karyosomata are separated into two groups to form the daughter-nuclei. In one they are separated without accompanying division, as in Fig. 124. In the other they divide in such a way that each half of the karyosoma is destined to pass into different daughter-nuclei. In this case we get two forms. In one form the karyosomata, if they are short, become arranged into a nuclear plate in the equator of the spindle, and by division and separation of the halves we get two daughter-plates that pass to the poles, and become the daughter-nuclei, but if they are long, they lie along each spindle-fibre and are bisected in the equator as in Figs. 101 and 115. In the other case the daughter-segments are produced by a longitudinal splitting of the loop, as shown in Figs. 114, 118, and 119, in which splitting usually occurs early, while the spirem figure still persists, and in this case no true equatorial plate may form, but be only the expression of separating loops passing each other on the way to their respective poles. Between all these different

methods there are connecting links. Carnoy calls such a case as is seen in Fig. 109 *stenotic* division, while similar separation with more complex spindle and asters, as in Fig. 124, he terms *cytodiĕresis.*

Finally, the karyosomata reach the poles and pass through stages of fusion of the larger bodies and segmentation of the smaller, so that the nucleus appears homogeneous because of its very fine reticulum. Then from this point the changes continue along the upward path to the resting phase, wherever that may be. While undergoing this fusion, the hyaloplasm in which the chromatin-granules are imbedded become much increased, so that if the chromatin is sparse we get vesicular unions, like Fig. 125. This hyaloplasm is parachromatin, and it undoubtedly enters partly into the formation of the spindle-fibres; in Fig. 126 appears to be the only source of these.

Concerning the nucleoli that may be present, besides the reticulum or mitom and the plasmatic nucleolus, there exist the most diverse views. In the first place, we must call attention to the fact that very diverse structures have received this name by different writers. The nodes of the reticulum, the karyosomata, the groups these may form when unresolved by the lens, all have received this name. The true nucleolus seems to disappear during division, and to be gradually built up by fusion of granules at its close. It has been supposed that it dissolved in the nuclear sap, and was absorbed by the mitom, or that it was directly connected with the mitom, and so incorporated into it. Thus Pfitzner called its substance *prochromatin*, as being a store from which the mitom replenished itself, but has lately changed the name to pseudochromatin, and other authors think it is of accidental value. Those who think with Strasburger, Fraisse, Kassel, and Brass that the chromatin is food-substance and the hyaloplasm the real idioplasm, find no difficulty with this body. But it must be remembered that it also has hyaloplasm, so the difficulty is unsolved. What is the meaning of those polar corpuscles (not to be confounded with the polar corpuscles considered above) seen in Fig. 112, *c*, *o*, *d*, which multiply as the loops multiply, and whose number is approximately two or three times that of the loops? It almost seems as if they were related to the karyosomata, as the endoplastules of Protozoa are to the endoplasts. They may have come by the segmentation of the nucle-

olus, and in that case this body is a paranucleolus over against the mitom. But these bodies may have come from the plasmatic nucleolus of Carnoy, and so we are still in doubt.

Another unsolved problem is concerning the connecting fibres that remain between the retreating karyosomata. In plants they help to build the cell-plate, and the nucleus gets reconstructed without their being absorbed. In animals they seem to be absorbed, for, if left outside, they form the paranucleus of Platner (see Fig. 123), which is later absorbed by the nucleus to form the spindle. They are thus made of substances similar to those which enter into the parachromatic reticulum, and, when not absorbed by the nucleus, they join the other fibres of the cytoplasmic reticulum, from which they can no longer be distinguished. Thus the chromatin of the nucleus must make more hyaloplasm, from which a new parachromatic reticulum can arise.

There is some evidence of the existence of microsomata that are not chromatin; in the cytoplasmic reticulum these are not so active in their fusions and segmentations as the nuclear microsomata, but still they do this, for the spindle-fibres and rays, when extra-nuclear, have been observed to segment and fuse. This can easily be understood by combining with Heitzmann's schema the idea of units in the cell. Strasburger and Pfitzner recognize the microsoma as such a unit, and we have shown that there are numerous units of differing complexity and degrees. When two organisms differ in the number of units that enter into their structure, such difference is one of degree in the ordinary sense, but when two organisms differ by belonging to higher or lower stadia of organization, such difference constitutes a *discrete degree.* Such degrees separate the Protozoa from Metozoa, a man from the social organism, a cell from the microsoma, a microsoma from a gemmule. Though here further study is needed to discover the number of stadia visible to the microscope, Nägeli has admirably discussed the stadia that lie between the chemical molecule and the micellæ, and Altmann has suggested that the bacterial organisms are of the same grade of organization as the microsoma. *Each node in a reticulum may be conceived as a unit.* We have already seen how, when chromatin segments, it may leave a funiculus of hyaloplasm (with or without a wall). This connecting piece of hyaloplasm may break by being drawn towards the

centres on either side of it, or it may, like a pseudopodium, reach out and obtain a fresh connection with a neighbor. This is admirably illustrated in Fig. 123. In this way it is *that a reticulum can be transformed into a mitom or a fibre.* The observations of Rabl and of Retzius on the formation of the mitom become intelligible. By the attraction of the hyaloplasm along definite paths, and their separation along others, we may also see how a nucleus arises in a cell, as in Fig. 2. By mutual attraction the microsomata fuse. Why they segment may be explained by assuming that certain gemmules or societies of gemmules differentiate from the others and serve as governing centres, about which the rest flock. Individuality arises in this way everywhere. The cause of union between two units of like order, which constitutes sexual union, is not so apparent. We find this occurring only where a slight difference has arisen, so that, Lankester says, "they may mutually gain each other's experience." At bottom all the phenomena of the cell-life may be referred to attractions, and through its action the reticulum becomes the organ of movement.

There is considerable evidence that successive cell-divisions differ in their karyokinetic phenomena. We know that the number of karyosomata in the segmenting-egg are fewer than in the tissue-cells, and that they are shorter. There must be a change somewhere. But in gametogenesis two successive generations may differ, as can be seen by Figs. 123 and 124. We may start in gametogenesis with direct division, pass on to generations produced by budding or by stenosis, and finally reach the complex phenomena of the segmenting embryo. We know only a little about this. Our knowledge compares with what we should know, as the knowledge of zoologists, before embryology, compares with their present knowledge. When we reflect that we must observe cells in all periods of their life and all the generations of cells as they differentiate, and we must do this for all the different animals, and the results must be corroborated by different observers, morphologists need not quarrel for lack of room nor sit idle for lack of work. We can also understand why karyokinesis is such a mysterious phenomenon. *Cell-division must be understood ontogenetically and phylogenetically.*

(To be concluded.)

EDITORS' TABLE.

EDITORS: E. D. COPE AND J. S. KINGSLEY.

For twenty years the American Naturalist has played an important part in the history and development of American science. In the seventeen thousand pages which compose the twenty volumes there is contained not only an epitome of the world's scientific progress but a large proportion of the original investigation carried on in this country. The magazine has won for itself an honorable place in the scientific literature of the world, and to-day its position is higher than ever before. Through these twenty years it has pursued but a single policy, and in its fundamental features it is, in 1887, the same that it was in 1867. It has constantly aimed to make American natural history prominent, and to occupy a happy medium between a technical magazine and one in which all science is sacrificed to popularity. It has aimed to instruct rather than to amuse; it has sought accuracy rather than elegance of diction. Throughout it has aimed at independence, and its columns have ever been open to all. There have been many changes in these twenty years, but these have been in way of expansion, rather than alterations of the original plan.

In mere size alone the development has been considerable. The volume which has just been closed contained nearly twice the matter that was given twenty years ago. Then fifty writers contributed notes and longer articles to a single volume, now the contributors number nearly one hundred. In the beginning there were four editors, now the editorial corps numbers nine. In the first number the minor notes were grouped under the heads of Botany, Zoology, and Geology. To-day it has, besides these, departments of Anthropology, Embryology, Entomology, Geography and Travels, Microscopy, Mineralogy and Petrography, Physiology and Psychology, as well as one embracing the miscellaneous scientific news of the day. All of these facts show progress, and apparently a growth in the right direction. They indicate that the magazine had friends and has made more friends; and to all these, both subscribers and contributors, the American Naturalist returns its most cordial thanks. In the past the editors and proprietors have endeavored to show

their appreciation of public favor by increasing the size and improving the quality of the magazine. There is still room for improvement, and it is confidently believed that the present volume will surpass any of its predecessors, a belief that seems warranted by the reputation of the J. B. Lippincott Company of Philadelphia, which has assumed the business management. The enterprise shown by this house in other lines is an ample guarantee that in all that pertains to the mechanical execution the future volumes will be better than the past. It also ensures a wider field of influence and a larger circulation, and this, in turn, will result in still further improvements.

With the present volume there is a change in the editorial management. Professor A. S. Packard, to whom is due the credit of starting the magazine, and who has labored unceasingly for its success for twenty years, retires from the management. He has won the thanks of every lover of Natural History, and has fully earned the relaxation and release which his retirement will give him. Certainly no one has done more for the spread of a knowledge of nature than he. His place will be taken by Dr. J. S. Kingsley, of Malden, Massachusetts, who needs no introduction to the readers of this journal, and who prefers to begin his editorial labors without further announcement. The department of Entomology will be in the able hands of Professor J. H. Comstock, of Cornell University, Ithaca, New York.

In the years 1878 and 1880 Congress, by concurrent resolution, ordered the publication "by the public printer, with the necessary illustrations," of the third and fourth volumes of the final report of the U. S. Geological Survey of the Territories, at that time under the direction of Dr. F. V. Hayden. These volumes were to contain the reports on the Tertiary and Mesozoic Vertebrata of the West, by Professor E. D. Cope, which were to be based on materials preserved in the collection of that naturalist. On the faith of these resolutions of Congress, Professor Cope undertook extensive explorations in all parts of the far West, at his own expense, examining various regions from Southern Texas to Northern Montana, and from Kansas to Oregon and California. This was necessary, since Dr. Hayden's survey was not in a financial position to sustain the expenses of the investigations in the field of vertebrate palæontology, and he had no other collectors of ver-

tebrate fossils than those employed and paid by Professor Cope. The result was the accumulation of a large amount of material, which includes about one thousand species of vertebrata from all the vertebrate-bearing horizons in the Western half of North America, excepting one, and a large amount of material from most of the Eastern bone-bearing beds.

In 1880 the survey under Hayden was abolished on pretence of a consolidation, which was never carried into effect, and a new survey was organized under the direction of Major J. W. Powell. The unfinished work of the Hayden survey was placed in the hands of Major Powell by the following order of the Secretary of the Interior, Teller:

"WASHINGTON, Sept. 27, 1882.

"MAJ. J. W. POWELL,

"*Director U. S. Geological Survey, City:*

"SIR,—The letter of Dr. H. V. Hayden, dated June 27th, bearing your endorsement of July 20th, relating to the unpublished reports of the survey formerly under his charge, is herewith returned.

"You will please take charge of the publications referred to in the same in accordance with the suggestions made by Professor Hayden.

"It is the desire of this office that these volumes shall be completed and published as early as practicable.

"Very respectfully,

"H. M. TELLER, *Secretary.*"

In spite of the above order, no part of Volumes III. and IV. of the Hayden series which was not previously in the printer's hands, has been sent to the Government printing-office, nor even been prepared for it since they came under the control of Major Powell. The verbal promise made to Dr. Hayden and Professor Cope by Major Powell, that part of the unfinished work represented by these volumes would be undertaken and completed as part of the work of the new survey, was not fulfilled; and inquiry finally elicited the statement from the director that this unfinished work would not be published by him.

Under these circumstances, Professor Cope, with the advice and consent of Dr. Hayden, applied to Congress for a small appropriation to pay the expenses of the preparation of the reports. The amount required per annum was three thousand eight hundred dollars, of which one thousand dollars was for an artist, seven hundred and twenty dollars for a preparateur of materials, and two thousand and eighty dollars for the preparation of the text and completing the reports. A lump amount was at first

asked for in the winter of 1885–86, but failed for want of the approval of the Secretary of the Interior. The smaller amount asked for at the session of Congress of 1886–87 was approved by the Interior Department and by the Senate, but was lost in the conference between the committees of the Senate and House, during the last days of the term.

This explanation is due to the various palæontologists and others who are interested in the completion of the work so successfully begun sixteen years ago, and for which so many preliminary publications have been made. The long delay in publishing the illustrations, of which many have been prepared, is thus accounted for, although the inconvenience experienced by students is not diminished thereby.

Pending the consideration of the question by Congress, letters approving or urging its favorable consideration by that body were received from Professors Baird, Osborn, and Scott in this country, and Flower, Gaudry, Rütimeyer, and Zittel in Europe. Notes favoring such action by Congress appeared in the *Jahrbuch für Mineralogie* and *Cosmos* in Germany.

RECENT LITERATURE.

Ridgeway's Nomenclature of Colors.[1]—This work has a value to others than naturalists, for it gives first a large number of hints upon the selection of water-colors, pointing out thirty-six of the most useful and most permanent forms, and then how these can be combined to make one hundred distinct shades. Next is a comparative vocabulary of the names of colors in English, Latin, German, French, Spanish, Italian, Norwegian, and Danish. Illustrating this part of the work are ten colored plates, which contain one hundred and ninety-two distinct shades, each one named, while the explanation of each plate tells how these can be produced from the thirty-six colors deemed most essential for the water-color artist. As will readily be seen, this illustrated nomenclator renders the work of great value to the artist as well as to the naturalist, who has frequently considerable difficulty in his descriptions, of deciding exactly the meaning of nearly synonymous terms. Could this nomenclature have a further

[1] Ridgeway, Robert: A Nomenclature of Colors for Naturalists, and Compendium of Useful Knowledge for Ornithologists. 8vo. pp. 129, pls. 17. Boston: Little, Brown & Co., 1886.

introduction, and its terminology replace the meaningless terms like "elephant's breath," etc., introduced in trade, it would have a very beneficial effect. As to the correctness of the colors we cannot in all cases decide. We have never seen clothes worn as long as the famous ones of the Spanish queen, but should judge that the representation of "Isabella color" was about the hue that linen would assume under such conditions.

The only bibliographical omission we observe is the absence of reference to the two handsome volumes of Hay.

The remainder of the book is more especially suited for the ornithologist. It contains a vocabulary of the technical terms used in descriptive ornithology, which occupies fifty-eight pages; tables for the conversion of metric into English measures, and others for reducing inches to millimetres. The seven plates which illustrate this part of the book give the parts of a bird named. The portions of the head, shapes of wings, different markings of feathers, shapes of eggs, and comparisons of millimetres with English and French inches. The most noticeable omissions in these plates are those of the shapes of bills and feet. The work is well printed and bound, and will doubtless find a sale among others than the ornithologists, for whom it is specially intended.

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Pelseneer, Paul.—Notice sur un Crustacé de la craie brune des environs de Mons.—Notice sur un Crustacé des sables verts de Grandpré.—Note sur la présence de *Caradina desmaresti* dans les eaux de la Meuse.—Notice sur les Mollusques recueillis par M. le Capitaine Storms dans la région du Tanganyka.—Notice sur les Crustacés Décapodes du Maestrichtien du Limbourg. Ext. Bulletin. Mus. Roy. d'Hist. Nat. Belgique, iv., 1885–1886. From the author.

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GENERAL NOTES.

GEOLOGY AND PALÆONTOLOGY.

Notes upon Warping of the Earth's Crust in its Relation to the Origin of the Basins of the Great Lakes.—Evidence of unequal oscillation of continental areas, producing warping of the crust of the earth in the valley of the Mississippi and in the basins of the Great Lakes, is of importance. Numerous borings have been made by the Mississippi River Commission—along the course of the Mississippi River, and on its flood-plains between Lake Providence, La., and New Madrid, Mo.—that have passed through the alluvium and entered the Lignitic clays, which Mr. Wilson (of the Commission) identified as those of the Lignitic (Eocene) group of Professor Hilgard.

From measurements of these borings, given in the Report of the Commission for 1881, I have found that the slope of the bed of the preglacial valley, for a distance of three hundred miles below New Madrid, is only 0.41 foot per mile, while that of the modern surface throughout the same region is 0.62 foot. Between Lake Providence and the Gulf the slope of the surface is only

0.35 foot per mile, while that of the ancient bed is indefinitely greater, as shown from the record of the borings of the deep well at New Orleans. From New Madrid to St. Louis the slope of the valley is 0.73 foot per mile, but above it is reduced to about half a foot, throughout a long stretch below Rock Island Rapids. Above the Rapids (where the fall is twenty-two feet in fourteen miles), for two hundred miles the slope, so much nearer its higher waters, is again reduced to only 0.28 foot per mile.

The valley at St. Louis is about eight miles wide. Within a mile of its western side, as shown at the eastern abutment of the St. Louis bridge, the old channel reaches to a depth below the flood-plain of one hundred and thirty-six feet, increasing towards the eastward. Therefore there is every reason to conclude that from New Madrid to St. Louis, or even above it, the floor of the buried valley slopes less than that of modern days, although the borings upon its margin are not so deep as those at New Madrid, which are several miles away from the edges of the flood-plains.

Above St. Louis, the valley, with a breadth of several miles, narrows more or less gradually, except at two places, as we ascend it for eight hundred miles. At these two places the contraction is sudden, and only adjacent to them does the river flow over hard rock. The lower of these two exceptions is along the Des Moines Rapids, at Keokuk, adjacent to which General G. K. Warren discovered a buried channel through which the river once flowed. The other locality where the valley is narrow is below Rock Island. Above here the valley of the Mississippi broadens out and joins the valley of Rock River of Illinois. Along the Rapids, which are on the western side of Rock Island, the river passes over a limestone-bed, which dips at a low angle down its course. From this point to the mouth of the Mississippi the size of the valley is more or less in conformity with the erosive power of a constantly-increasing body of water. But from Rock Island down to Muscatine the river flows through a comparatively narrow cañon, which is quite out of keeping with the size of the valley above and below this section, showing an origin under different physical conditions. At Muscatine it suddenly widens out to eight miles. General G. K. Warren and other gentlemen, besides the writer, have endeavored to find an adjacent buried channel of commensurate importance with the size of that above and below this region, but without success.

Northward of St. Louis the floor of the buried valley rises. It is not known whether the modern channel of the Des Moines Rapids at Keokuk has been produced by erosion into the rocky floor, exposed by the upward warping of the earth's crust, or by the river deflected over hard rock by the filling up of Warren's channel to the westward.

As has been stated, the slope of the valley above Rock Island Rapids is only half that below. But a more striking difference

exists along this floor of the buried channel, as shown by various borings at Prairie du Chien, La Crosse, and elsewhere, from which we learn that the bottom does not slope southward, but actually to the northward. Even at La Crosse, two hundred miles north of Rock Island Rapids, the bed of the old channel is fifty feet below that at the Rapids.

From the above observations it is apparent that there is a transverse warping across the Mississippi, which has culminated at Rock Island, and exposed a floor of the hard rocks to be eroded during later geological days. The uplift is further demonstrated by the observations of Mr. W. J. McGee, who finds that an old channel of the Mississippi leaves the mouth of the Maquoketa River, and is coincident with it for several miles, and then passes southward to the valley of the Wapsipenicon, with which it is identical to its mouth. This old valley is from one to three miles wide, and rises to fifty feet above the Mississippi River. It is cut not only through the Palæozoic rocks, but also through the Drift and Loess. The floor consists of alluvium only. Accordingly, the uplift or warping has been quite recent. As this channel is above Rock Island, its presence does not relieve the necessity for an explanation of the stricture in the valley below that place, but only shows more plainly the warping of the strata in later geological times, which has brought up the old rocky floor of the region to be chiselled into by the waters flowing since the Drift epoch.

This warping is part of a fold which extends across the continent to the Great Lakes, and has a bearing upon the production and separation of their basins. A low anticlinal extends from the head of Lake Ontario westward, between Lake Huron and Lake Erie, and beyond, as was long ago pointed out by the geological survey of Canada. It is along the axis of this fold that the Dundas valley—part of the ancient outlet of the Erie basin—is located, where the dip of the strata upon the southern side is twenty-five to thirty-seven feet per mile to west of south, and eighty feet and upward upon the northern side in the opposite direction. In the peninsula (thus rendered somewhat weak) between the Lakes Ontario and Erie local warpings are visible in many places. Furthermore, Mr. G. K. Gilbert has observed that the old shore-lines about Lake Erie rise to the eastward and northward, thus showing that the basins across the old outlet have been recently raised.

The same gentleman has also observed that a conspicuous terrace south of Lake Ontario rises one hundred and thirty feet in proceeding from the western end of the lake to Oneida Lake, south of its eastern end. From this region northward to Adams Creek, Jefferson County, the terrace rises one hundred and seventy feet more; but north of this it has not been seen (*Science*, September 11, 1885). Further evidence of warping along a line

probably reaching northward as far as the eastern end of the lake has been gathered by Mr. W. J. McGee, who finds a recent uplift of twenty-five feet in Virginia to four hundred to five hundred at New York, which has not been followed farther northward.

The Palæozoic strata at the eastern end of Lake Ontario has a much greater dip than at the western end; for near the outlet the Trenton limestones dip from fifty-three feet in a mile to three or four degrees, and in direction eastward of south. A depression of only ten or twelve feet from the outlet of the lake southward, during a period of high continental elevation, when the valley of Lake Ontario was formed (and we know from the soundings in the St. Lawrence, farther down, that the elevation reached to twelve hundred feet at least), would be sufficient to make the broad plain adjacent to the St. Lawrence a continuation of the valley of Ontario, and drain all of its waters.

The time of general warping doubtless took place during the periods of oscillation between that of high continental elevation before the Ice Age, and the subsequent submergence in the later Pleistocene epoch to perhaps seventeen hundred feet, in Ontario and Michigan, below the present level (some of the present terraces north of Lake Ontario are certainly marine), and that of the adjustment to the present relative elevation of land and sea, which, to a considerable extent, has been since the Terrace epoch.—*J. W. Spencer, Ph.D., F.G.S., University of Missouri*, January, 1887.

The Formations of the Belly River of Canada.—In his report on the geological survey of the Dominion, Mr. George M. Dawson describes a new formation, to which he gives the name of the Belly River epoch.

The deposit is immediately overlaid by the Pierre or number four cretaceous of Meek and Hayden, which in turn is overlaid by the Laramie. The Belly River beds are of lacustrine origin. It is well known that the Pierre beds are of marine origin, while the Laramie beds are lacustrine. The Pierre fauna of the Dominion is identical with that already known, while the Belly River beds also contain numerous fossil remains. The plants have been studied by Sir William Dawson, who finds them to be identical with those of the Laramie. The same conclusions have been reached by Mr. Whiteaves as to the Mollusca, and Professor Cope finds the vertebrates, of which there are numerous species, to be identical with those of the Laramie. It is difficult to believe that the same land fauna continued during two geological epochs so generally different as those of the Pierre and those of the Laramie. It is also difficult to believe that a deep-sea marine fauna could have occupied the interior of the continent during the stage of elevation presented by the Laramie. It is therefore suspected that

there has been some error of observation. It must be said, however, that the conclusions of Mr. Dawson have been confirmed by two other competent members of the survey.—*E. D. Cope.*

The Cross-Timbers of Texas.—The paper recently read before the Washington Philosophical Society on "The Cross-Timbers of Texas," by Mr. Robert T. Hill, who is a native of that State, and now connected with the United States Geological Survey, gives some interesting data about that hitherto little studied region. The article demonstrated that these two belts of anomalous timber, instead of representing quaternary or tertiary basins, are merely the detritus of outcrops of arenaceous strata, those of the eastern member being probably of the age of Dakota sandstone, and the western of a sandy group at the base of the entire cretaceous series, part of which are of undetermined Mesozoic, and are given the name of "Dinosaur Sands" by Mr. Hill, while part of them are of undoubted Carboniferous age. He furthermore shows that the topography of the entire central region is the result of extensive denudation, whereby the members of the geologic series, from the marine tertiary to the Carboniferous coal-measures, are successively exposed along the line of the Texas Pacific Railroad, from Elmo to Millsap. The most interesting feature of Mr. Hill's paper, however, is that he demonstrates the existence of a marine group of the Cretaceous in Texas lower than any heretofore recognized in America, and completely clears up, by methods of stratagraphic palæontology, the vagueness that has hitherto accompanied our knowledge of that region. The palæontological results of the work are also very interesting, and will be studied and presented by Dr. C. A. White.

MINERALOGY AND PETROGRAPHY.[1]

Rosenbusch's "Massige Gesteine."—It is rarely that the revision of a standard work in any branch of science is followed with so much interest as has been the case with Professor Rosenbusch's "Mikroskopische Physiographie der Mineralien und Gesteine," the first part of the second volume[2] of which has recently been issued. When the first edition of this classical work appeared (1877) the study of rocks by means of the microscope had but just begun to take its place as an independent science, requiring new methods of investigation, new apparatus for these investigations, and new modes of reasoning by which the truths revealed by them could be made use of in the elucidation of many obscure problems in the broader science of geology. It is not surprising, then, that as petrography increased its store of

[1] Edited by Dr. W. S. BAYLEY, Madison, Wisconsin.

[2] Massige Gesteine, I. Abt., Stuttgart, 1886. E. Schweizer bart'sche Verlagshandlung (E. Koch).

observed facts, and the number of minds devoting themselves to the application of these facts to the study of the rocks themselves and to their origin became greater, new fields were explored and new facts were observed, which seemed to contradict many of the deductions obtained by the earlier investigators, and rendered a revision of their views necessary. This is especially true in regard to the classification of the massive rocks, the separation of these rock-masses into families,—into groups, all the members of which are characterized by certain general properties which mark them as belonging to the same group, and distinguish them from the members of other groups. Until we know the history of every rock on our globe and can trace it back to its origin through all the changes which it has undergone since its first existence as a distinct portion of the original molten magma, all attempts at a perfect classification of these bodies must be futile, and the classification itself must be an artificial one. As we can never expect to know everything relating to even a single rock type, so we can never expect to possess a perfect classification of rocks. The differences in structure produced during the solidification of molten masses by slight differences in the conditions of temperature and pressure under which they cool are so great, and our knowledge of the effects of these differences is so limited, that we must be content with that classification which best conforms with the facts known and incorporates them in a consistent whole. In no *natural* science can we hope for more than this, and least of all can we hope for it in petrography, the materials of which are the embodiments of the action of largely unknown conditions on substances of whose original nature little can be *positively* known. It is safe to affirm that no classification of rocks ever proposed has met with such general acceptation as that of Professor Rosenbusch's as developed in the first edition of his "Massige Gesteine." That this, however, did not fully meet the requirements of the rapidly-growing science has been acknowledged for some years past. That classification was based upon the fundamental notion that rocks erupted before the Tertiary period in geological time, in consequence of certain conditions then prevailing, possessed structural and mineralogical characteristics which distinguished them from those of more recent age. This, then, was taken as the ground upon which to separate all massive rocks into two great divisions,—the pre-Tertiary and the recent rocks. These were again subdivided according to their structure into granular, porphyritic, and glassy rocks; and finally the members of the subdivisions were classified by groups in accordance with their mineralogical composition. Recent investigations, especially those of Italian and American workers, have shown that structure is dependent not upon the age at which rock-masses were formed, but rather upon the geological conditions under which they were produced. A mass

of molten material which flowed out upon a land surface and there cooled, no matter in what geological period, always possesses characteristics which distinguish it from a mass of the same chemical composition which cooled slowly at some distance below the surface. It is probable that rocks of the latter class have been formed throughout all time since the beginning of the Laurentian, and may be in process of formation at present, but at such depths that we can never hope to see them. That most of the plutonic rocks with which we have to deal were really formed early in the earth's history, is due merely to the fact that that portion of the earth's crust in which they are found has been eroded to such an extent as to lay bare its innermost depths.

In the new volume under consideration, Rosenbusch characterizes these deeply-formed rocks as possessing, I., each of their constituents in but one generation, and, II., so developed that the different individuals have mutually interfered with each other's growth, thus giving rise to the granular (körnige) structure. When none of the constituents possess crystal outlines, the structure is called *hypidiomorphic;* when certain of the constituents are so developed, the structure is known as *panidiomorphic.* Rocks which were produced at great depths, and consequently possess this granular structure, are designated as intrusive or plutonic (Tiefengesteine).

The intrusive rocks are subdivided in accordance with their chemical and mineralogical composition into granites, syenites, eleolite syenites, diorites, gabbros and norites, diabases, theralites, and peridotites. All these are characterized by the possession of the *hypidiomorphic* structure, in which by far the larger part of the constituents are *allotriomorphic* (possess a form due to external causes and not to the action of intermolecular forces,—*i.e.*, are not developed with crystal outlines). When any of the intrusive rocks occur as sheets between older rocks (are "Lagerförmig") they assume some of the peculiarities of rocks which cooled at or near the surface. In other words, some of their constituents become *idiomorphic* (possess crystal outlines), and the rock tends to the *panidiomorphic* structure, such as many of the diabases.

On glancing over the list of the names of intrusive rocks, it will be noticed that in it are included, with the single exception of teschnite, all those formerly described as pre-Tertiary with a granular structure. In the place of teschnite we find the new type theralite.

The abolition of the old type teschnite is due particularly to the work of Rohrbach, who, in 1885, after a thorough examination of specimens from every locality within his reach, concluded that in not a single instance could any trace of nepheline be detected. He referred most of the teschnites to the diabase

group. This disposition Rosenbusch accepts as the correct one for many of the rocks heretofore denominated teschnites, and among them that from Teschen, Moravia, named by Hohenegger teschnite, in which Zirkel, in 1868, and Tschermak, in 1869, thought they had found nepheline. Since, therefore, the original teschnite is probably only a variety of diabase, it was thought best to drop the name as descriptive of intrusive nepheline-plagioclase rocks, and to substitute for it the name theralite (θηρᾶν—seek diligently).

This name is intended to cover all intrusive rocks containing nepheline and plagioclase as prime constituents. That such rocks occur has not yet been positively proved, although the recent work of Wolff in Montana and the earlier work of Hawes and of Harrington in the neighborhood of Montreal, Canada, render their existence probable.

The gabbros and the norites have been included together in one family, the former comprehending those plagioclase rocks in which a monoclinic augite (of a composition approaching that of diallage) occurs as the predominant bisilicate constituent, and the latter those in which this augitic constituent is orthorhombic. Every gradation between the typical gabbro and the typical norite is recognized as possible.

The diabases are regarded as occupying a peculiar position among the intrusive rocks. Their occurrence as sheets between clastic rocks allows them sometimes to assume certain of the characteristics of thin magmas which cooled at the surface, such as the possession of amygdaloidal upper surfaces, the association with them of tufas, etc. The greater mass of diabase, however, Rosenbusch describes as intrusive (in sheets or dykes), hypidiomorphic granular rocks, generally of an early geological age, though occasionally of a very recent one, which possess as essential constituents a plagioclase and augite. In his earlier description of this rock chlorite also was considered as essential. This mineral is now regarded as merely secondary, the last product in the alteration of the augite. In this connection occasion is taken to remark that uralitizatine is not a paramorphism of hornblende after augite, but that the change is probably due to loss of calcium,—the hornblende is an apomorph. The frequent association of epidote with chlorite would seem to confirm this view.

The new name Harzburgite is proposed for the hypersthene and bronzite peridotites, which Wadsworth in his "Lithological Studies" calls Saxonite.[1] Wadsworth's name is based on a description of Dathe's, which this writer himself acknowledges to be erroneous in some of its essential particulars.

The second great class is that of the dyke rocks. These are not as well characterized as the intrusive class. The conditions

[1] American Naturalist, Notes, May, 1885, p. 499.

under which they solidified have varied to such an extent, in consequence of differences in the thickness of the dyke, in the depths at which given portions crystallized, in the degree of conductivity of the rocks penetrated, etc., that all types of structure are found among them. As might be expected, this class is much less well defined than that of the intrusive rocks considered above, or that of the effusive rocks to be examined later. In it are included only those rocks which can neither be regarded as intrusive nor yet as effusive. They are divided according to structure into three distinct types,—I., the granitic; II., the grano-porphyritic; and, III., the lamprophyric. They all tend to the development of one or the other of their constituents in porphyritic crystals; in other words, they are all panidiomorphic.

The granitic class includes only aplite and beresite.

The structure of the grano-porphyritic type is defined by the name. They are porphyries in the sense that they contain certain of their ingredients in two generations, but differ from them in the possession of a holocrystalline ground-mass. Among the grano-porphyritic class are placed granite-porphyry, syenite-porphyry, eleolite-syenite-porphyry, diorite-porphyrite, and quartz-diorite-porphyrite. It will be seen that this class embraces most of those pre-Tertiary porphyritic rocks that are not true porphyries.

The lamprophyres are distinguished from the grano-porphyritic group by the prevalence of bisilicates and the subordination of the feldspathic constituents. They consist of a fine-grained to very compact (dicht) ground-mass, in which porphyritic crystals of biotite, augite, or hornblende are scattered. They all weather very readily, and, as a consequence, contain a great deal of calcite, so that in many cases before their structure can be studied it is necessary to etch their thin sections with a dilute acid.

The lamprophyres are subdivided into the syenitic and the dioritic varieties. The syenitic varieties include minette, characterized by the predominance of biotite, and vogesite, in which the place of the biotite is taken by hornblende or augite. The dioritic varieties embrace kersantite and camptonite. The latter name is applied to the porphyritic diorites described by Hawes[1] from the neighborhood of Campton, N. H. They contain porphyritic brown hornblende and lath-shaped plagioclase crystals in a ground-mass composed essentially of green augite, apatite, and a glassy base in which amygdules occasionally exist.

The third and last great class of rocks is that of the effusives (Ergussgesteine). It embraces those which were poured out upon the surface and then solidified. They are found in sheets and in volcanic streams (Decke and Ströme). There seems to be no reason why there should not be a corresponding effusive rock

[1] Mineralogy and Lithology of New Hampshire, 1878, p. 160.

for every intrusive one, if difference of structure is due merely to difference in conditions of cooling. As a fact, however, it is found that the effusive rocks are always more acid than their corresponding intrusive equivalents. This is accounted for by Rosenbusch on the assumption that during the gradual rise of the magma in the cracks through which it reached the surface enough time was consumed to allow of its separation into strata, the heavier, more basic portions accumulating towards the bottom, and the lighter portion floating on the top.

The characteristic structure of the effusive rocks is the porphyritic. The porphyritic crystals are supposed to have been developed at the period during which the rock was ascending to the surface. After it reached the surface another more rapid crystallization set in, and the result is a glassy or finely-granular ground-mass.

The effusive rocks are divided into two classes, according to age. This is the only remnant left of the old classification into pre-Tertiary and recent rocks. Here certain characteristics are noted in those rocks erupted at an early geological period, which distinguish them from the rocks of later eruptions,—*e.g.*, the ground-mass, of the older rocks, is more lithoidal in character than that of the younger ones, the appearance of their porphyritic feldspathic constituents is different, etc. Whether these differences are of primary or secondary origin is still a matter of doubt. The pretertiary effusive rocks are known as palæo-volcanic, the younger ones as neo-volcanic.

The palæo-volcanic rocks include the quartz-porphyries, quartz-free-porphyries, porphyrites, augite-porphyrites and melaphyres, and the pikrite-porphyrites.

The full discussion of the different varieties of the palæo-volcanic rocks and the entire discussion of the younger class are left to the second part of the book, which is promised to appear in a few months. It is of course impossible to give any adequate conception of the amount of new material incorporated in this volume, or even to mention all the important results reached in its consideration. Perhaps the most important of all the advances have been in the direction of what is now known as dynamical metamorphism, by the action of which a massive rock is made to assume a schistose structure. This mode of alteration is treated in some detail.

It is needless to say that the very latest publications have all been critically examined and their teachings made use of in developing the new system of classification. It is a matter worthy of note that quite a large proportion of the most instructive papers bearing on this subject have been presented by Americans.

Instructors in petrography, and all those to whom a ready knowledge of German is denied, will be glad to learn that a translation of both the first and second volumes of the "Mikro-

skopische Physiographie" is contemplated by Mr. J. P. Iddings, of Washington. It is proposed to omit those parts which are not essential to the production of a good text-book, and to incorporate the remaining portions in one volume. As the labor involved in translating the work is very great, it may be some time before the English version is given to the public.

BOTANY.[1]

A Study of the Growing Parts of the Stem of Pinus strobus. THE WHITE PINE.[2]—Before beginning work on this special part of the subject a cursory examination was made of the tissues in general as compared with that of *Pinus sylvestris*, the so-called Scotch Pine. Roughly speaking, they are the same,—a central pith, a zone of xylem varying in width according to the number of years' growth, the phlœum, outer cortex, and the epidermal system. But by direct comparison the tissue of the White Pine is seen to be more dense than that of its foreign relative,—the cells having a smaller diameter and the resin passages being smaller and less numerous.

In *Pinus sylvestris* there are two rows of resin passages in each year's growth of the xylem, one comparatively near each margin of the zone, while in *Pinus strobus* there is but one row, which lies towards the outer part of the zone. Sometimes an extra passage is found lying deeper in the xylem. On the contrary, in the outer cortical tissue of *Pinus strobus* are two rows of resin passages, the inner row being much larger than the outer one, but both being quite large, while there is but one row found here in *Pinus sylvestris*.

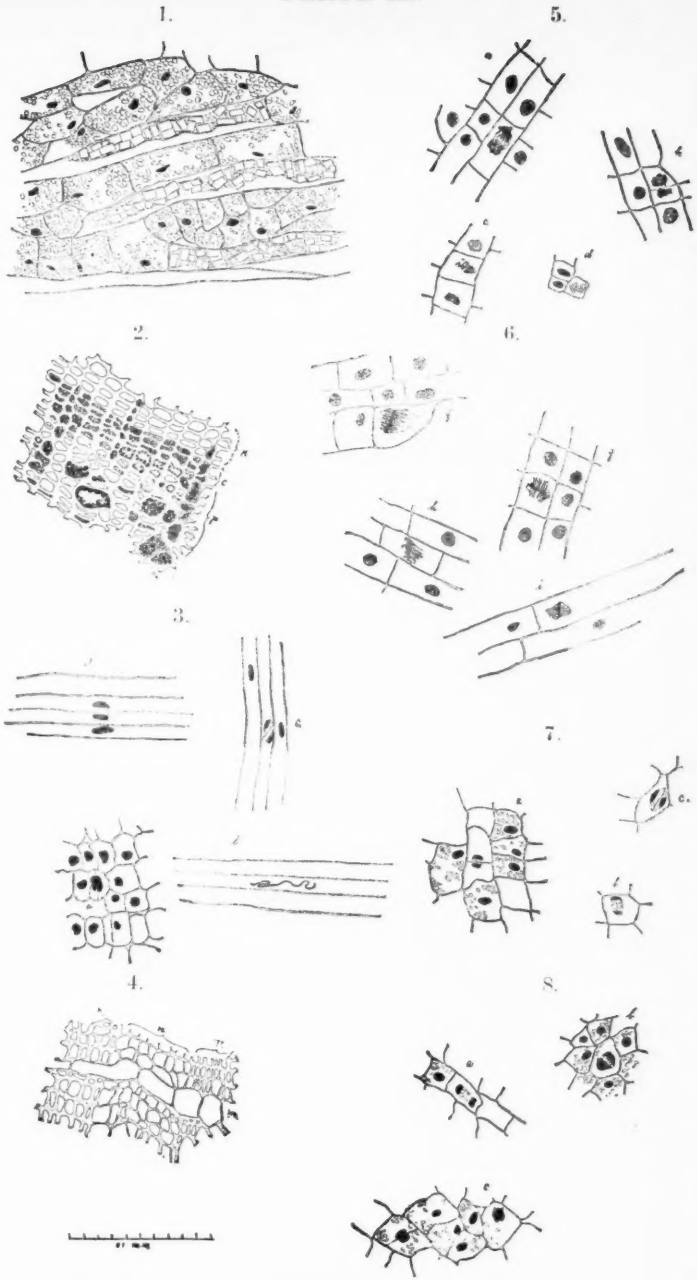
Growing from the epidermis of the bud and young shoot of *Pinus strobus* are many glandular, often capitate, hairs, composed of but two or three somewhat elongated cells, filled with densely granular matter. These appear to be secretory hairs, producing the resin that is found in such abundance in the bud of the White Pine. They were not found in the Scotch Pine.

In the phlœum, in elongated cells which are distributed irregularly throughout this tissue, with the exception that they never occur within a zone of about eight cells from the xylem, occur large numbers of crystals of oxalate of lime. Fig. 1 of plate is a camera drawing of a longitudinal tangential section through the phlœum of a one-year-old stem, showing parts of five of these cells, three of which contain crystals. These crystals do not lie in the cell-wall, but are embedded in a substance which more or less completely fills the cell, offers great resistance to acids, is

[1] Edited by Prof. CHARLES E. BESSEY, Lincoln, Nebraska.

[2] Selected for publication from original work of students in the botanical laboratory of the University of Michigan, 1885–86, and communicated by Professor V. M. Spalding.

PLATE IX.



not affected by ether, and stains from yellowish brown to dark blue with Hanstein's aniline violet. The cells surrounding these contain much starch and protoplasm, with usually a nucleus.

Resin passages are also found in the phlœum and outer cortex, which do not run parallel to the long axis of the stem. Some were found running radially from towards the centre. At one end of some of these radially directed passages they bend at, or nearly at, a right angle, and pass up the stem. The great majority, however, run longitudinally through the stem.

Looking at the stem as a whole, at the centre is the pith or central cortex, composed of loose parenchymatous cells, then the protoxylem, composed of groups of scalariform and spiral vessels, which merge into the zone of xylem, composed of elongated ligneous cells, whose radial walls are thickly pitted. Outside of this is the cambium, or "growing part," a zone of cells with cellulose walls, definitely marked off from the xylem, but merging without any distinction into the zone of phlœum. In the stem cut in the winter, when growth is arrested, there is a zone varying from about three to five cells broad, in which the cell-walls stain somewhat more quickly and deeply with Schultze's solution than those of the surrounding tissue, and the cells of this zone are more densely filled with granular protoplasm. Fig. 2 is a camera drawing of a cross-section of a stem in which growth had not yet commenced: (*x*) a few cells of xylem, (*c*) the cambium zone and (*p*) the phlœum, (*m*) a medullary ray reaching only into the edge of the xylem.

Beyond the cambium is the zone of phlœum, composed largely of sieve-tubes, but containing the elements before described. Next is the outer cortical zone, with elements very similar to those of the pith, and outside this the epidermal system.

This much with the view of obtaining a better understanding of the position and of the elements in which growth takes place.

My method in the work was as follows: Stems from one to four years old, and buds, or young shoots, as the case might be, were taken from a thrifty growing tree at periods varying from four to ten days apart, and beginning before the commencement of growth in the spring. This material was preserved in alcohol and used as desired. Schultze's solution and Hanstein's aniline violet gave the best satisfaction as staining agents: Schultze's solution for differentiation of tissues, the aniline violet for staining nuclei. To clarify the sections, after cutting I placed them in sulphuric ether for some time, which removed the resinous substances, then, if staining with the violet, I removed them to a reduced solution of this, and after overstaining removed the excess with alcohol by placing the sections in it for a short time, and afterwards cleared with clove oil and mounted in dammar.

Taking the bud first, as it seems the most suitable place to start with, I found the growth for a period of a few weeks proceeding much more rapidly in the cortical and medullary tissue than in any other place. The first signs of growth appeared about April 20; and in the material cut May 6, the cells of these tissues were in their most active state of division, longitudinal sections showing large numbers of dividing nuclei. At this time the ground tissue composed the greater part of the stem, though the vascular system had increased considerably. Soon the growth in the cortical and medullary tissues almost entirely ceased. May 27, cell-division had so nearly ceased in these tissues that I could find no dividing nuclei, though I spent much time looking for them; and in the same material cell-division was taking place along the cambium line.

But growth does not entirely cease, at least in the outer cortex, for I found cell-division here in a three years' growth.

Fig. 3, *a*, is a camera drawing from near the epidermis of a three-year-old stem, showing a nucleus that has divided and the new cell-wall just formed. I think, in this tissue, growth continues by cell-division as long as the tree lives. Growth also takes place here by these cells becoming somewhat larger, and they often become elongated somewhat tangentially.

As to the length of life of these cells I can say but little. Many were found, even in the first year's growth, which were empty and dead; but in the same tissue taken from the body of a tree eight inches in diameter the great majority of the cells contained protoplasm and nuclei. I do not think the central cortical tissue lives very long, though I found some cells of a four years' growth containing protoplasm and starch.

The main growth of the stem is along the line of cells designated as the "cambium zone." On one side the cells that are here newly formed pass into the xylem, on the other into the phlœum. As each year's growth of xylem is much larger than that of the phlœum, many more cells must go to the formation of xylem than of phlœum.

To all appearances, when the stem is growing, the cambium zone is but one cell broad, as all nuclei that show signs of division in this tissue are found along a straight line in a longitudinal radial section.

Fig. 3, *c*, is a longitudinal section through a three-year-old stem, cut May 26, showing cell-division through the shorter diameter of a cambium-cell, thus showing that there must be some growth in length after the stem is three years old.

I found neither protoplasm nor nuclei in the xylem more than one year old, but in cells of the medullary rays passing through the zylem, and which were four years old, I found protoplasm and nuclei.

Many cells of the phlœum, in all specimens examined, were

apparently empty and lifeless, but the great majority contained nuclei. Some of these cells must have been quite old, as I examined some sections of phlœum from the body of a tree about eight inches in diameter.

In studying the structure of the nucleus and the process of cell-division, I had about equal success in the three above-mentioned tissues.

Fig. 4 is from a drawing of a cross-section of a young shoot cut April 26, showing a few cells of the xylem (*x*), the newly-formed tissue (*n*), some cells of the old phlœum (*p*), and a medullary ray (*m*). In this shoot a zone about seven cells broad had formed.

To obtain some idea of the rate of cell-division I made an estimate of the number of newly-formed cells produced by the cambium in a piece of a three-year-old stem one inch long, cut April 26, by counting the number of cells in the breadth of the zone, the number of cells around the stem, measuring the length of a number of cells, and taking the average. Also, in obtaining the number of cells around the stem, I took four sections from different stems, but all of about average size, and took the average. By this means I estimated the number of newly-formed cells, in such a piece of stem one inch long, April 26, to be 560,640. As April 17 there were no signs of growth, and as I could find but few nuclei and cells in the process of division in the material cut April 26, and from the great number of newly-formed cells, I conclude that the entire process of cell-division can last but a very short time,—perhaps two or three hours.

Fig. 5, *a*, *b*, *c*, *d*, and Fig. 6, *f*, *g*, and *h*, are camera drawings of some of the forms of the dividing nucleus found in the medullary rays along the line of the cambium. These are all from a four years' growth, cut May 6 and 26.

Fig. 6, *i*, and Fig. 3, *b*, *c*, *d*, represent some forms found in the cambium from material the same as the above. Fig. 7 represents cells from the inner cortex of a young shoot cut May 6, and Fig. 8, the same from the outer cortex.

Forms essentially like all these drawn were found in each of the three tissues, and from these we can trace the process of growth of cell-division in the pine.

First the nucleus in a state of repose, the nuclear filament folded so as to appear to be a densely granular ovoid mass. Fig. 3, *b*, shows one of these filaments lying in the cambium of a three years' stem, which was probably straightened by the razor in making the section. It demonstrates the composition of the nucleus. About the first change manifest in division is the segmentation of the nuclear filament, shown in Fig. 5, *c* and *d*. Then these segments double and arrange themselves in a radial manner around a common centre, as shown in somewhat varying stages in Fig. 8, *c*, and Fig. 6, *g* and *h*. Then the formation of

the nuclear threads running off from the ends of these segments to the poles of the nuclear spindle, as shown at Fig. 6, *f* and *i*.

These "conjunctive threads," as Fol calls them, arrange themselves in such a manner as to form a double hollow cone with a common base. The segments of the filament then pass out along the line of these threads and gather at the two poles of the spindle. Fig. 5, *a*, and Fig. 8, *b*, show early stages of this transformation, and Fig. 8, *a*, and Fig. 7, *b*, a little later. The new cell-wall or "nuclear plate" is then formed, as shown in Fig. 7, *c*, across these threads at right angles and about midway between the two masses of filaments, the parts of each of which have now united and form a rounded mass, in appearance like the mother-nucleus. The formation of the nuclear plate continues until it reaches across the cell from side to side and forms a complete cell-wall. All these sections are radial longitudinal ones.—*Elmer Sanford.*

ENTOMOLOGY.

Critical Remarks on the Literature of the Organ of Smell in Arthropods.—[The following abstract of the more important portions of Kraepelin's criticisms on the works of writers on the olfactory organs of arthropods, may prove not unwelcome to our entomologists, who may never be able to obtain Kraepelin's rather rare pamphlet. See pp. 889 and 973 of vol. xx.—*A. S. Packard.*]

My own observations on different groups of insects agree, in general, with those of Perris, Forel, and Hauser, without being in a position to confirm or deny the varying relations of the Hemiptera. That irritating odorous substances (chloroform, acetic acid) cause the limbs to move in sympathy with the stimulus, I have seen several times in Acanthosoma; still it may be a gustatory rather than olfactory stimulus.

As regards Crustacea, there are no observations or experiments (except on Asellus) on the conjectural seat of their olfactory organs. It should be here mentioned that Jourdain has described and Professor Dohrn, in Naples, has reported to me that the Brachyura by a remarkable movement of their inner antennæ, which are almost continually in convulsive movements, seem to support the opinion long entertained of the perception of odors by the antennæ.

As to spiders, it is not certainly known whether and to what extent they share in the sense of smell. Robineau-Desvoidy (1842) said that their sense of smell is very well developed and localized in the mandibles, but Perris placed them in the lowest rank of arthropods, though he remarks on "the sensibility of their palpi to smells."

Turning now from speculation and simple observation to exact anatomical and histological data, the nerve-end apparatus seems

to have a distinct reference to the perception of odors. It comprises a structure composed of nervous substances which are enclosed in a chitinous tube, and either only stand in relation to the surrounding bodies by the perforated point, or pass to the surface as free nerve-fibrillæ.

Wolff's theory that the sense of smell is lodged in the skin of the soft palate-like roof of the mouth is published in a work of two hundred and fifty quarto pages, which shows so much skill, acuteness, and subtle reasoning that his views prevailed for several years, and were adopted by Graber in his well-known work on insects. Forel appears to have been the first to oppose Wolff's conclusions, both on theoretical grounds and from his experiments on Polistes and Sphex. Leydig, in his work on Amphipoda and Isopoda (p. 235), expresses the view that "this nasal skin possesses nothing more special than other regions of the skin which should be considered as tactile." I think that Leydig is here perfectly correct, and that those small pit-hairs are plainly tactile organs, since such must be present in the mouth near the organs of taste. Moreover, it is generally doubtful whether such direct sense-perceptions as smell and taste can pass through chitinous membranes; a perforation of their terminations has never been observed in the hairs under consideration. Hence the analogously formed hairs in the suctorial canal of the dipterous labrum [hypopharynx] in their whole arrangement (they stand in two longitudinal rows like the trees on each side of an alley) show that they are formed to feel and repel solid bodies, rather than to smell them. The presence of a gland differing in the nature of its secretion from the other glands of the mouth, on which Wolff laid so great weight, should not have much force as an argument, since we know as good as nothing of the chemistry of digestion and the secretions in insects necessary for it. The apparatus is better fitted by its situation for a gustatory apparatus. Hence we should adopt Leydig's view of the tactile nature of these minute hairs so long as no further anatomical and physiological data prove their gustatory function.

In insects there is a remarkable and fundamental difference in the structures of the parts supposed to be the organs of smell. Erichson (10) was acquainted only with the "pori" covered by a thin membrane; but Burmeister (11), in his careful work on the antennæ of the lamellicorns, distinguished pits at the bottom of which hairs rise from a glass-like tubercle, from those which were free from hairs. Leydig (14) afterwards was the first to regard as olfactory organs the so-called pegs (kegel), a short, thick hair-like structure distinctly perforated at the tip, which had already by Lespès (38) in Cercopsis, etc., been described as a kind of tactile papilla. Other very peculiar olfactory organs of different form Forel (Fourmis de la Suisse) discovered in the antennæ of ants, which Lubbock ("On some points," etc.), according to a short

notice of Forel, incorrectly associated with the nerve-end apparatus found by Hicks in other insects. This manifold nature of the antennal organs has by the last investigator, Hauser (22), from thorough studies of the nerve-elements belonging to them, been not simplified but rendered more complicated. According to this naturalist we may distinguish the following forms which the olfactory organs may assume: 1. Pale, tooth-like chitinous hairs on the outer surface of the antennæ, which are perforated at the end; nothing is known as to the relation of the nerve passing into it (Chrysopa, Anophthalmus). 2. In pit-like depressions of the antennæ arise *nerve-rods* (without a chitinous case) which stand in direct relation with a ganglion-cell lying under it. These pits are either *simple*, viz., with only an "olfactory rod" (Tabanus and other Diptera, Vanessa), or *compound* (Muscidæ and most other Diptera, and Philonthus). It seems important that these pits are partly *open* (in the above-named groups of insects), and partly *closed* and covered with a thin membrane, under whose concavity the olfactory rods end (Orthoptera, Melolontha, and other lamellicorns). 3. Short, thick pits sunken slightly into the surface of the antennæ, and over this a chitinous peg perforated at the end, in whose base, from the interior, projects a very singular *nerve-peg*, which is situated over an olfactory ganglion-cell, and provided with a slender *crown of little rods*, and flanked on each side by a flagellum-cell (Hymenoptera). 4. Round or crevice-like pits covered over by a perforated chitinous membrane with nerve-rods like those in 3, but in place of the flagellum-cell with "membrane-forming" cells spread before it. Hauser finally mentions further differences in the ganglion-cells sent out into the nerve-end apparatus. These exhibit in Diptera and Melolontha only one nucleus, in Hymenoptera a single very large one (with many nucleoli) and three small ones, in Vanessa six, in Orthoptera a very large number of nuclei, etc. We add beside all these different forms also the Forelian flasks ("microscopical stethoscopes" of Lubbock) not known to Hauser, and the champagne-cork organ in ants; thus we have in fact a very great variety, so that it seems difficult to understand how Hauser could nevertheless ascribe a common function to all these nerve-end apparatuses.

As the final result of my researches I may state *that the great variety of antennal structures previously described may be referred to a single common fundamental type of a more or less developed free or sunken hair-like body which stands in connection by means of a wide pore-canal with a many-nucleated ganglion-cell.*[1] *The latter sends only a relatively slender nerve-fibre (axial cord) through*

[1] Perhaps this structure might more correctly be considered as a ganglion with numerous cells, since in fact the whole structure of the nerve-mass, namely, in the Hymenoptera, has a great similarity with that of the crustacean antenna.

the pore-canal into the hair; but the same is enclosed by epithelial cells which surround the pore-canal.

Kraepelin thus sums up our present knowledge of the olfactory organs of Coleoptera: *The terminal apparatus of the organ of sense in the antennæ of beetles consists in each case of a chitinous, delicate or thick, long or short hair-like structure, which is planted in the middle of a more or less arched, "dome-like membrane" closing in the wide pore-canal of the antennal wall. This membrane extends over the pore-canal at the same level as the surface of the antennal integument* (Geotrupes, Strangalia), *or it rises as a cupola in the middle of a beaker-shaped pit* (Melolontha, Buprestidæ, Dytiscidæ). *Often such sense-organs* (*either with or without special pits*) *are so united that they stand associated in flat depressions of the surface of the antennæ, the so-called "compound" pits* (Melolontha, Strangalia, Euchroma, Lucanus, etc.).—*K. Kraepelin.*

ZOOLOGY.

Mimicry in Amphipods.—Dr. Carl Bovallius describes (*Nova Acta Reg. Soc. Sci. Upsaliensis*, xviii., 1886) a new genus of Hyperid Amphipods, the three species of which are remarkable for their mimicry of jelly-fishes. The head and five, six, or all seven of the thoracic segments are enormously inflated, so that the anterior part of the body closely resembles the bell of a medusa, while the feet and compressed abdomen hang down like the tentacles of the mimicked form. For these forms the generic name Mimonectes is proposed, and even a new family has to be instituted. Among the other more remarkable characters are the following: The eyes "do not form a continuous mass on each side of the head as in the other Hyperids, but consist of six to ten large ocelli scattered over the lower side of the head. These do not show such long crystallic [*sic*] elements as in Phronima, Rhabdosoma, and others, but seem to be composed each of a great many granular, fine, light-breaking corpuscles interspersed with dark brown pigment." The innervation of these ocelli is peculiar; some receive their nerve-supply directly from the brain, while in others the filaments seem to arise from the œsophageal commissures. Whether this is actually the case or not remains to be determined by sections of fresh specimens, but it is interesting to note that all the ocellar nerves (except two) arise *behind* the nerves supplying the antennæ. The "bell" of the animal is filled with a liquid enclosed by a thin pellucid membrane, but as all the material was alcoholic, the nature of the fluid could not be ascertained. The alimentary canal showed no traces of cæca or hepatic glands. The three species are *Mimonectes lovéni*, from the Atlantic; *M. sphæricus*, from near the Canary Isles; and *M. steenstrupii*, from the mouth of Davis Strait.

Australian Cladocera.—It is a well-known fact that the eggs of various fresh-water animals (notably those of Entomostraca) will withstand long desiccation, but still the experiments detailed by Mr. G. O. Sars have considerable interest. A correspondent sent him in Christiania, Norway, some dried mud from the shores of a fresh-water lake in tropical Australia. This mud was placed in water, and from it were hatched out one Copepod, one Ostracode, a species of Polyzoan, apparently belonging to the genus Plumatella, and five species of Cladocera. These last are made the subject of an article of nearly fifty pages and eight plates in the *Forhandlinger Vidensk. Selsk. Christiania* for 1885 (1886). These species all belonged to genera (Daphnia, Diaphanosoma, Ceriodaphnia, Moina, and Leydigia) already known from European waters, and the species themselves closely resembled those of the antipodes, notwithstanding that they came from localities thousands of miles apart and which have entirely different environments. These facts recall to the author the close similarity—even identity—of the crustacean species of Italy and Norway, and he concludes that one cannot lay too great stress on the importance of birds in the distribution of these forms. Sars's paper is, like many others, written in English.

The Myzostomata.—Nansen's beautifully-illustrated "Contributions to the Anatomy and Histology of the Myzostomata" is the last publication of the Bergens Museum. The text (sixty-eight pages) is in Norwegian, but a *résumé* in English of twelve pages places the substance of the article within reach. Two new species are described with great detail, the integument, nervous system, sensory organs, segmental glandular sacs, hook apparatus, alimentary tract, genital organs, complemental males, and hermaphroditism being discussed. Nansen comes into frequent conflict with Beard. Thus he does not believe with Beard that the dicœcious forms of Myzostomata were the primitive type, and the hermaphrodite the secondary. He finds nothing resembling the epidermal sense organs or chitinous hollow rods described by Beard, nor can he accept Beard's account of the development of the nervous system by which the larval nervous system disappears and has nothing to do with that of the adult. Nansen considers the "suckers" as "segmental glandulous sacs," stating that they are ciliated, and lack the muscular walls described by Graff. Whether they are homologous with the segmental organs of the Annelids is left undecided. The fact that they do not communicate with the body cavity is the greatest objection to this view, but the ready answer to this is that, unless the cavities in which the ova are situated are such, the cœlom is absent.

Nansen's conclusions as to the systematic position of the

Myzostomata we quote (from the *résumé*) in full: "I cannot agree with Beard in regarding the Myzostomida as belonging to the Chætopods; there are too many dissimilar features in their structure, and I do not think that their development, as described by Beard, is 'quite that of a Chætopod.' The absence of a preoral ring of cilia, the relatively small development of the preoral lobe, and the great development of the body part of the larva are no insignificant differences; they show that the larva is not a little differentiated. The presence of a preanal ring of cilia is common to most Annelid larvæ, and the larvæ of Mollusca, Bryozoa, etc., also usually possess such a ring. In the absence of this ring, as well as in the rudimentary development of the preoral lobe, the larvæ of Myzostomida resemble those of Sipunculus; in their general structure there is, however, but little resemblance to be traced. I am inclined to regard the Myzostomida as a peculiar, distinct group, belonging to the Annelids, related to the Chætopods, but also showing a tendency towards some of the Arachnids (Linguatulida, Tardigrada, and perhaps Pycnogonida) and Crustaceans; they are sprung from the Trochophora; among the Archianelleda their ancestor has been chiefly related to that of Histiodrilus; on the other hand, it has also been related to that of the Arthropods, because the Myzostomida really show, in their structure, a tendency towards these. They are therefore one of those groups presenting the greatest interest as a subject for phylogenetic studies." The present reviewer fails to recognize the arthropodan resemblances of these forms. He is inclined to regard them as Annelids but remotely related to the Chætopods, parasitism having extensively modified them.

Anatomy of Echinorhynchi.—The Acanthocephali have been regarded as devoid of a digestive apparatus, and Lespès's discovery of what he considered the alimentary tract in the pyriform body in the proboscis of *Echinorynchus claviceps*, met with but little acceptance. Recently Megnin has been studying the subject, and gave the result of his researches before the Scientific Congress of Paris. In order to settle the question it was necessary to study these worms at a period before the development of the sexual organs, and when the nutritive system was in full function. Megnin found Echinorhynchi encysted in the cellular tissue of some Varanidæ from the Sahara. These proved to be in a larval stage and to have a digestive apparatus composed of two long convoluted tubes, each giving rise to numerous cæcal diverticula. The whole presents an analogy to the alimentary tract of the Trematodes. In some species, as the *E. brevicollis* found in *Balænoptera sibbaldi*, the digestive apparatus persists and acquires considerable development. In others it undergoes a degeneration and is to be sought in the "lemnisci," structures, heretofore of problematical nature, occasionally regarded as sali-

vary glands. The larvæ have a rudimentary dorsal vessel, and this, with their proboscis and aquiferous apparatus (which, however, is well developed in the adult), shows the relation of the Acanthocephali to the Nemerteans or Rhynchocœla, while the digestive apparatus is more like that of the Trematodes. They can no longer be arranged with the Nematodes.

Argulus and Mortality of Fishes.—In the October number of this journal (vol. xx. p. 856) Mr. F. L. Washburn records an annually recurring extensive mortality of different species of fish in Lake Mille Lac, Minnesota, and describes as the cause of death a Siphonostome, the abdomen of which is furnished with an umbrella-like disk. Although this description hardly answers to an Argulus, yet I think the mode of occurrence and the great mortality point to the parasite being a member of this genus. I do not remember to have seen before an account of such devastations by Argulus in America, but similar accounts from Europe are not uncommon.

Mr. Washburn's note reminded me of the circumstance that two years ago Mr. A. C. Lawson, of the Geological Survey of Canada, brought me an account of a similar mortality of an undetermined species of Coregonus in the Lake of the Woods. He had preserved a number of the parasites, which I marked at the time *Argulus coregoni* Thorell (?), with the intention of determining afterwards whether the Canadian and Norwegian species should turn out to be identical. I find now that the characteristic copulatory ridges on the swimming legs of the male are very different in the Canadian species from those in *Argulus foliaceus* or *coregoni*. Dr. J. S. Kingsley has undertaken to see whether they agree with those in any described American form.

It may be of interest to note here that Leydig, in a recent communication to the *Zoologische Anzeiger* (No. 237), announces that the "poison-sting" of Argulus is in reality a sense organ, the "poison-duct" a broad nerve-tube, and the "poison-gland" a part of the fat body, so that the great mortality caused by Argulids is not to be attributed to any poison injected with the bite.—*R. Ramsay Wright, University College, Toronto,* January 8, 1887.

The Irish Red Deer.—In the March number of the *Zoologist* R. J. Ussher states that the Irish red deer lingered in the mountains of Knockmealdown, Counties Waterford and Tipperary, in 1774, and that its last haunt was Erris, County Mayo, where a few existed as late as 1847, when they were slaughtered for food by the famine-stricken peasantry. The only examples now left are preserved by Lord Kenmare and Mr. Herbert, of Muckross, in County Kerry. Among the occasional notes in the same magazine is one to the effect that a specimen of the American

rusty grackle (*Scolecophagus ferrugineus*) was shot last autumn at Cardiff, Wales.

The Birds of India.—W. T. H. in Ward's *Science Bulletin* gives a short notice of the comprehensive ornithological survey of India that has for several years been carried on under the direction and at the expense of Mr. A. O. Hume, Secretary to the Government. Not only India, but British Burmah, Ceylon, the Malay Peninsula, and the Andaman Islands are included in this work. Besides doing a vast amount of field-work himself, and writing largely upon the subject, Mr. Hume has constantly kept from one to three corps of collectors in the field. Among the results of the work is a collection of over forty-five thousand bird-skins and unnumbered eggs at Simla, a superb four-volume work upon the Game Birds of India, and a work on the Nests and Eggs of Indian Birds. Mr. Wm. Davison, one of Mr. Hume's collectors, has found five hundred and eighty species in Tenasserim, and seven hundred and twenty-eight in British Burmah.

The Zoology of British Burmah.—Apropos of the preceding note comes a condensed account of the contents of the "Gazetteer of British Burmah," for which we are indebted to the *Revue Scientifique* of April 1. The mammiferous fauna presents many relations to that of the Sunda Isles, and includes four species of rhinoceros (*Rhinoceros sondaicus*, *Rh. indicus*, *Ceratorhinus crossii*, *C. sumatrensis*), the tapir (*Tapirus malayanus*) and *Orcella fluminalis*, a peculiar form of fresh-water dolphin, the anatomy of which has been fully described by Mr. Anderson. The bats hibernate as in Europe, and the genus Taphozous is particularly remarkable for the reservoir of fat stored in its tail for winter use. The roussettes do not hibernate.

Mr. E. W. Oates enumerates seven hundred and seventy-five species of birds, or a hundred more than is contained in all Europe. Of these, four hundred and fifty are also found in Hindostan, about one hundred of which are water-birds common to all the Old World, and winter visitants of Burmah; one hundred and fifty Malayan species, the northern limit of which is in Burmah; fifty species common to Burmah, Siam, and China; and sixty species at present supposed to be peculiar to Burmah. Some species, as *Pavo muticus*, *Megalurus palustris*, *Crypsirhina varians*, are found in Burmah and Java, while absent from Malacca; and species which in Hindostan occur only in the Himalayas at a considerable elevation, are here found at the sea-level. Birds identical with or closely related to those of Europe are few; among them are *Cotyle riparia*, *Chelidon urbica*, *Strix flammea*, the cuckoo, the wrens, the skylark, the pipits, and Saxicola.

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The variety of the fauna is explained by that of the country,

which is so varied that in an hour one can pass from grassy plains interspersed with rice-fields to the inaccessible precipices of granitic mountains; from a sea of bamboo jungles to the shady retreats of the virgin forest; and from the rich tropical vegetation of the coast to the pine-woods of the heights. Innumerable water-courses, interminable creeks, broad marshes, valleys alternately inundated and dried up; chains of mountains of various elevations diversify the surface of this province, giving it an unequalled array of flowers and fruits, birds, reptiles, insect, and molluscs.

The list of reptiles given by Mr. W. Theobald includes four crocodiles and more than seventy serpents, fifteen of which are among the most deadly, and shows that in this province Malayan and Indian species meet.

Among the fishes are many of those singular forms which seem as much at home on land as in water, such as the tree-climbing *Anabas scandens*, the Ophiocephalidæ and Trichogaster, which have a reservoir of air above their gills; Clarias, with an accessory respiratory apparatus; and Saccobranchus, with its long air-vessel extended across the dorsal muscles and communicating with the gills. The singular modifications of the organs of respiration in these fishes are an adaptation to the æstivation that follows the rains. Some, as *Oph. punctatus*, *Rhynchobdella aculeata*, and *Amphipnous cuchia*, live in summer buried two feet below the surface. After a storm fishes appear as if by magic; the Ophiocephalidæ glide, eel-like, from pond to pond through the wet herbage, and the *cuchia* lies on the ground hidden among the tall weeds, ready to spring into the water when disturbed. Many species, both marine and fresh-water, migrate regularly in accordance with the monsoons. Many mount to the mountain torrents to lay their eggs, and descend with the falling waters, while their young often remain above till the ensuing year. The siluroids of these rapid torrents are provided in their youth with a thoracic adhesive apparatus which disappears in the adult. *Oph. striatus* builds with its tail a nest among the aquatic plants beside the rivers. The nest is formed of the stems of herbs, which it bites off for the purpose; the male guards the eggs, and both take care of the young until they are large enough to go alone, when they chase them, and, it is said, even eat them if they refuse to disperse. The male of *Arius burmanicus* hatches the eggs, from fifteen to twenty, in his mouth, and during the incubation takes no food.

The prosobranchiate Gasteropoda are more numerous and varied in form than those of India; Cyclophoras attains two and a half inches diameter. Pomatias reappears here, and so also does the South American genus Nenia. The conchological fauna of British Burmah shows that the country was primitively an archipelago separated by arms of the sea, for upon

the cretaceous hills of the valleys of Salween and Aracan occur isolated species, more numerous and interesting than those of the flat country that separates them. Two hills fifteen miles apart have a different molluscan fauna, and many forms are confined to this region. Besides the, to some extent, special fauna of these hills near Maulmain, three other molluscan faunæ can be distinguished: first, that of Aracan and southern Pegu, considerably resembling that of Assam and of the Himalayas; second, that of Upper Burmah and Thayet, resembling that of India, Central Asia, and China; and, third, that of Tenasserim, allied to that of Siam and the Malay Peninsula and connected with that of the Malayan Archipelago.

Description of a New Species of Wood-Rat from Cerros Island, off Lower California (*Neotoma bryanti* sp. nov.).—Mr. Walter E. Bryant has kindly presented to me the skin and skull of a wood-rat collected by him January 11, 1885, on Cerros Island, off Lower California, in lat. 28° 12′ N.

Concerning its capture he writes as follows: "On the shore of a small, shallow lake, about two thousand feet in altitude, on Cerros Island, I found a nest composed of the large dry leaves of the Maguey plant (*Agave*). It was built among small living plants of the same kind, which held it so firmly that I could not overturn it. It was about four feet high and as much or a little more in diameter at base. One of our party set fire to the structure, and while it was enveloped in flame and smoke a scorched rat ran out, which I shot. This was the only nest and only rat seen on the island."

This unfortunate circumstance, together with the fact that the skin was preserved in brine, explains the very poor condition in which it reached me. Enough remains, however, to show that the species differs remarkably from all known representatives of the genus in possessing a very dark belly, which, in this individual at least, is absolutely concolor with the back and sides. It may be added that the dark color of the under parts is in no way due to the scorching above mentioned. In all the previously described species the belly is pure white, or nearly white, in sharp contrast to the color of the upper parts.

This animal may be distinguished from its congeners by the following characters:

NEOTOMA BRYANTI sp. nov. *Bryant's Wood-Rat.* (Type No. $\frac{2838}{1833}$, male, immature; Merriam Collection.)

Size large, about equal to that of eastern specimens of *N. floridana;* hind foot, 37 mm.; tail naked, its length uncertain, part of it being wanting; ears, apparently about the size of those of eastern *floridana*, but too imperfect to admit of measurement; head, throat, and body all round, dark slate color, almost sooty,

exactly the same below as above, without trace of whitish on under parts. The feet may have been white, but it is impossible to tell from this specimen.

Behind each ear there is a patch of fulvous-tipped hairs, and it is possible that a superficial wash of this color was spread over much of the upper parts where the tips of the hairs have been singed off. The skull shows that the animal from which it came was full grown, but not quite adult. The grinding down of the molar teeth has only recently begun; consequently the deep plications along their sides are of unusual length. The enamel of the front upper molar forms two well-marked re-entrant angles of the inner side of the tooth. The pattern of the crowns of the molar teeth in both jaws is the same as in eastern specimens of *floridana* of corresponding age. The incisive foramina extend posteriorly beyond the plane of the anterior roots of the first molars. The pterygoid fossa is narrow, as in all the western forms of the genus,—very unlike its condition in eastern *floridana*. The condyloid process of the mandible is decidedly longer than in any of the other species. The zygomatic breadth is noticeably less than in the other members of the genus, which may be due in part to the immaturity of the individual, the zygomæ usually arching outward with age. The length of the molar series is conspicuously greater than in eastern skulls of *floridana* of the same size, and the molar series are much nearer together. This last character, however, is common to the western representatives of the genus.

Comparison with the western forms of the *floridana* type has been intentionally withheld because of the unsatisfactory if not chaotic condition in which these forms have been left by recent writers.

The new species is named in honor of its discoverer, Mr. Walter E. Bryant, of Oakland, California.

The following cranial measurements will suffice for present purposes (all measurements in millimetres):

Basilar length (from one of the occipital condyles to posterior edge of alveola of incisor of same side)	41.80
Basilar length of Hensel (from inferior lip of foramen magnum to posterior edge of alveola of incisor)	38.20
Occipito-nasal length (from occipital crest in median line to most anterior point of nasals, a measurement of very little value)	45.80
Greatest zygomatic breadth	22.50
Least breadth of frontals at interorbital constriction	5.50
Greatest length of nasal bones	17.70
Greatest width of nasal bones anteriorly	5.
Least width of nasal bones posteriorly	2.10
Least width of rostrum in front of zygomæ	4.80
Distance between outer rims of alveolæ of upper incisors	4.80
Distance from posterior rim of alveola of incisor to anterior rim of alveola of first upper molar	12.50
Distance from posterior rim of alveola of incisor to post-palatal notch ("palatal length")	20.80

Length of upper molar series measured on the alveolæ	10.40
Length of upper molar series measured on the crowns	8.30
Distance between alveolæ of upper molar series anteriorly	2.70
Distance between alveolæ of upper molar series posteriorly	4.40
Width of pterygoid fossa	2.
Apex of post-palatal notch to foramen magnum	17.
Height of cranium from inferior lip of foramen magnum	11.20
Fronto-palatal depth (taken at middle of molar series)	11.80
Greatest length of single mandible (exclusive of incisors)	29.30
Distance from incisors to first molar (on alveolæ)	6.30
Length of under molariform series measured on the alveolæ	9.80

C. Hart Merriam.

Zoological News.—SPONGES.—Franz Vejdovsky points out that the recently described *Spongilla glomerata* Noll is the same as *Sp. fragilis* described by Dr. Leidy in 1851, and since described under several different names. He also gives a list of the known fresh-water sponges of Europe, enumerating eight species distributed among the genera Euspongilla, Spongilla, Trochospongilla, Ephydatia, and Carterius.

ECHINODERMS.—C. F. and P. B. Sarasin describe (*Zool. Anzeiger*, ix. pp. 80–82, 1886) the poison apparatus of the leather-urchin, *Cyanosoma urens*, a new genus and species. From the integument arise slender stalks bearing on their extremities strong connective-tissue poison-sacs.

Hubert Ludwig, in the same journal (p. 472), describes a six radiate condition in *Cucumaria doliolum*. Out of about one hundred and fifty half-grown specimens which he obtained at Naples, five had this peculiar structure, which affected not only the tentacles and ambulacra, but made itself evident in the internal organs. Such variations are extremely rare among the Holothurians.

WORMS.—Dr. H. Schauinsland has a note (*Zool. Anzeiger*, ix. 574, 1886) upon the excretory and genital organs of the Priapulidæ, a family of Gephyrean worms, in which he points out that the so-called genital organs of these animals are not simply genital in function, but that, in fact, they are but portions of the ducts of the excretory organs, the epithelium of which gives rise to the genital products. He also states that these worms differ from the other Gephyrea in that the ova and spermatozoa do not escape into the body cavity, but are directly expelled into the sea.

In a paper read before the Linnean Society of New South Wales, June 30, 1886, Mr. J. J. Fletcher described six new species of earth-worms from Australia in addition to the three previously known. Of these, two belonged to the genus Perichæta, two to Notoscolex (a new genus), while two new genera, Didymogaster and Cryptodrilus, are created for the other two. Those previously known belong to the genera Lumbricus, Digaster, and Megascolides.

Prof. R. Ramsay Wright described at the meeting of the

Zoological Society of London, June 29, a new ectoparasitic Trematode under the name *Sphyranura osleri.* In its position it is intermediate between Gyrodactylus and Polystomium, and was found upon Menobranchus.

MOLLUSCS.—Kobelt in a "Nachtrag" to his former papers on the Molluscan fauna of Nassau (*Jahrb. Nassauichen Vereins*, Bd. 39, 1886) reviews, among other molluscs, the Unionidæ of Nassau, and describes, besides several varieties, *Unio rhenanus*, *U. kochii*, and *Margaritana freytagi* as new! Eight plates illustrate the paper.

The rarest of the Cypræas is possibly *Cypræa decipiens.* It was described by Edgar A. Smith in 1880 from a single worn specimen, which until recently was the only one known in any collection. It somewhat resembled a young *C. thersites*, and some had doubts as to the validity of the species. Recently several specimens have been obtained from the pearl-divers of Northwestern Australia, and these show conclusively that the species is a good one. It is said that the large green turtle feeds upon these molluscs.

Usually molluscs are very tolerant of those commensals, the oyster-crabs, which make their homes within their valves. At a recent meeting of the Zoological Society of London, Henry Woodward exhibited a specimen of the pearl-oyster (Meleagrina) from Australia in which a male Pinnotheres was enclosed in a cyst of pearl.

Bednal, in the *Transactions of the Royal Society of South Australia*, enumerates five species of Murex and one of Typhis as being found on those shores.

CRUSTACEA.—Collett, in a paper on Rudolphi's rorqual (*Balænoptera borealis*), records the presence (*Proc. Zool. Soc. London*, 1886) of the parasitic copepod, *Balænophilus unisetus*, on this whale. It is regarded as very rare, and has before been recorded but twice, and then on *Balænoptera sibbaldii.*

MYRIAPODS.—Berlese has a monograph of the Italian Iulids in the seventeenth volume of the *Bulletin of the Italian Entomological Society.*

According to G. Saint-Remy the brain of Scolopendra is much more like that of Hexapods than like that of either Crustacea or Arachnida.

ARACHNIDA.—At a recent meeting of the Entomological Society of Washington, Dr. Marx announced the finding of the European *Epeira diadematа* in Minnesota.

At the meeting of the Linnean Society of London, November 18, 1886, Mr. A. D. Michael exhibited specimens of the mite Argus which had been received from Australia, and which were apparently identical with the celebrated *Argus persicus*, the bite of which is said to produce delirium and even fatal results.

EMBRYOLOGY.[1]

Notes on Two Forms of Cestoid Embryos.—While engaged on the systematic study of the entozoa of marine fishes in the laboratory of the United States Fish Commission, Wood's Holl, Massachusetts, I have made notes and sketches of different stages of development of several species of Cestoidea. Without attempting at this time to give a detailed account of any one species, I wish to present a few notes on two forms which are of frequent occurrence.

To illustrate the first I have chosen a cyst taken from the peritoneum of the bluefish (*Pomatomus saltatrix*), and containing an embryo Rhynchobothrium. (Fig. 1.) Cysts like these, either of the same or closely related species, are abundant in most of the Teleostei, and are also occasionally found in Selachians. In the specimen under consideration the length was 12 mm., the breadth at the widest part 6 mm. When removed from its host the following points could be made out. The outer covering or cyst proper was oblong, larger at one end than the other, and tapering uniformly; thin, transparent, and delicate, with yellow granular patches, apparently masses of lymph-cells, on the surface at the larger end. When the cyst was broken open an endocyst (*blastocyst*, Diesing, "Revis. der Ceph. Ab. Param.," Introduction, p. 3) was released. After the escape of the endocyst from its enveloping cyst, the latter retained its shape and was not irritable or contractile. It was easily separable into a thicker outer and thinner inner layer, both hyaline and formed of connective tissue.

The endocyst when released from its capsular envelope was white and opaque, but became translucent, with a faint bluish tinge, when subjected to the action of the compressor and viewed by transmitted light. In form, while somewhat variable, it is usually club-shaped; much larger at one end than the other; the larger end blunt and rounded. The breadth of the larger end is uniform for about one-third the length of the endocyst, at which point there is a sudden constriction, beyond which the breadth diminishes gradually to the smaller end. When placed in sea-water it continues in a state of activity for hours. There is no decided locomotion, but a continuous series of movements, consisting of alternate contraction and extension of different parts of the sac-like mass and feeble lateral movements of the smaller end. In this condition the appearance of the endocyst is that of a thick-walled sac, the walls of which are made up of granular protoplasm with a thin investing membrane, and filled with clear, highly refractile globular masses. When placed under the compressor and slight pressure applied, the embryo Rhynchobothrium could be seen lying in a loose, irregular coil in

[1] Edited by Dr. JOHN A. RYDER, Philadelphia.

the large end of the blastocyst. (Fig. 2.) A sinuous vessel, revealing the existence of a water vascular system, could be plainly seen extending along each edge of the blastocyst, apparently uniting in the median line at the smaller end. At the larger end they seem to be merged in the common parenchyma. In the immediate vicinity of the embryo the blastocyst is more transparent than in other parts, and the embryo seems to be held in position by a limiting membrane which lines the blastocyst and surrounds the embryo. When considerable pressure is applied the embryo is forced through the walls of the larger end of the blastocyst. The parenchyma is then seen to be confined to the thick walls of the blastocyst, as it does not flow out when the walls are ruptured. I succeeded in separating the wall of the blastocyst into two distinct coats, the outer one much thicker than the inner. In the outer coat three distinct layers were distinguishable; an outer granular layer, under which was a layer of longitudinal muscular fibres, and under this a thick layer in which were the characteristic refractile masses. These layers were not separable from each other. The thin inner coat, which was easily separable from the outer, was very delicate and contained a few irregular, flat, granular masses. The presence of transverse muscular fibres was not demonstrated, although their existence was shown by the power which the blastocyst had to contract and expand laterally. They probably lie in the outer granular layer.

The irritability and contractility of the blastocyst continue for several hours after the embryo is removed. In earlier stages of the development of similar forms, before the embryo is clearly outlined within the blastocyst, the individuality of the latter is even more clearly marked, and is strongly suggestive of the Sporocyst of a Trematode with the beginning of a Cercaria at one end. The endocyst or blastocyst may therefore be regarded as an intermediate or transition form, which is probably developed from a six-hooked larva, as in most other Cestoidea, and which, after the manner of a nurse, gives rise to an embryo by internal gemmation. This embryo, when ready to escape from the blastocyst, is a scolex similar in form to the adult, and if transferred to a proper host would develop directly into an adult strobile.

The embryo, when freed from the endocyst (Figs. 3, 3 *a*, and 4), was quite active, and consequently definitely accurate measurements of many of the dimensions were impossible. Its length was about 24 mm., although it was capable of varying this to a considerable degree both by contraction and extension. The bothria are two in number, marginal, oblong, widely divergent behind, approaching each other, but not uniting, in front; notched on the posterior border and obscurely two-lobed; edges free, thin, and mobile. Length of bothria, measured while somewhat flattened under the compressor, 2.23 mm.; breadth of head, com-

pressed, 2.72 mm. Proboscides, four, very long, slender, cylindrical, and armed with recurved hooks of different sizes. The proboscides were not entirely everted, but by counting the series of hooks which are exposed, and allowing for the part which is inverted, which can be plainly seen through the transparent walls of the proboscis, the result is about one hundred series of hooks arranged in spirals. The spirals are nearly 0.05 mm. apart, and the proboscides about 4.80 mm. in length. There are about fifteen longitudinal rows of hooks. These rows do not coincide exactly with the axis of the proboscis, but make about one and a half turns around it from base to apex. The hooks in these longitudinal rows present the following differences. (Fig. 6.) Three contiguous rows have small, recurved, stoutish hooks, which lie in groups of two, one hook immediately in front of the other, and each group of two thus formed corresponding in position with a single hook in each of the other longitudinal series. The central of these three rows does not have the hooks as distinctly placed in groups of two as the two remaining rows. At the bases of the proboscides these hooks are 0.0152 mm. in length, increasing to 0.02 mm. at the apex, with the breadth of base 0.0102 mm. throughout the series. On each side of this group of three longitudinal series lies a series of small, slender, slightly recurved hooks. These hooks are 0.0127 mm. in length at the base of the proboscis, increasing to 0.02 mm. at the apex, with the breadth of base 0.0076 mm. Each hook of these two series corresponds in position to one of the groups of two in the three series first mentioned. The remaining series of hooks are ten in number. It is rather difficult to estimate the exact number of these longitudinal series, since the transverse spirals are not in even curves, but have a slight zigzag or sinuous course, so that the exact number of longitudinal series in a given part of the circumference is not always plainly shown. In one proboscis I counted eleven of these series, but in another, of which I had a plainer view, there were certainly but ten. These hooks are much larger, stouter, and more sharply recurved than those in the other series. The length of one of the largest near the base of the proboscis was 0.0356 mm., with a breadth of base of 0.0254 mm. Towards the apex of the proboscis they are a little longer than this. These larger hooks are not of uniform size, those adjoining the smaller longitudinal series being smaller than those farthest from them. In the transverse spirals formed by these hooks there is a tendency to form two faintly-defined groups of three hooks and one of four, the hooks in these groups of course standing side by side.

The proboscis-sheaths (Fig. 4) are long and spiral. A contractile ligament was clearly defined in each and could be traced out into the proboscis, where it appeared as a tubular band containing a fluid in which floated a few granules. Towards the end

this tubular ligament merged imperceptibly into the proboscis, and the fluid interior with granules became the interior of the inverted proboscis, with, at first, small and scattered rod-like hooks, and towards the apex of the inverted proboscis, with normal hooks attached to the inner parietes.

The front end of the long and slender contractile bulbs lies about 10 mm. back of the apex of the head; length 2.46 mm.; breadth 0.24 mm. The contractile bulbs, as in all the Trypanorhyncha, are thick-walled. The walls are composed of diagonal muscular fibres, which interlace, making angles of about 70° and 110° with each other. These organs act in much the same manner as the bulb of a syringe. By their contraction the fluid contents is forced into the proboscis-sheaths and proboscides. The column of fluid thus forced into the proboscides causes them to unroll like the finger of a glove that has been turned in. The contractile ligament, noticed above, extends the entire length of the proboscis-sheath and is attached to the inner parietes of the bulb; by its contraction the proboscis is invaginated from the apex. When the embryo was first liberated the proboscides were entirely retracted; when, however, pressure was applied, they unrolled. In this condition the proboscides are very beautiful objects, being quite transparent, while the chitinous hooks have a brilliant vitreous lustre. When fully extended the proboscides throw themselves into graceful spiral curves. When the pressure is released they are apt to be withdrawn.

The bothria, in life, are transparent, finely granular, with a few scattered, refractile globular masses similar to those in the walls of the blastocyst. The tubular neck, when flattened under the compressor, presents the following features. The centre, surrounding the proboscis-sheaths and extending nearly to the edges, is filled with large, irregular granular masses closely packed together. Outside of this inner core is a layer of longitudinal muscles, and outside of this a layer of vascular tissue, in which the reticulated vessels of the water vascular system can be plainly seen. Outside of this again, and forming the outer coat of the neck, is a layer of dense tissue, which, as nearly as can be ascertained without stained sections, consists of transverse muscular fibres.

The water vascular system consists of a net-work of vessels in the borders of the bothria which connects with large sinuous vessels in the centre of the head, and together with these with the reticulated subcuticular vessels of the neck. Back of the contractile bulbs the system is represented by two pairs of vessels which lie in sinuous curves near each edge of the embryo. One of these vessels was much larger than the others, and ended in a bulbous enlargement.

Behind the contractile bulbs the body has the appearance of an elongated sac, filled with granular parenchyma, but with the

refractile masses much smaller than those in the blastocyst, and enclosed in an investing membrane about 0.005 mm. thick. The posterior end is terminated by a papillary, button-like process, which is retractile and covered with a dense coat of minute, straight, hair-like bristles. (Fig. 5.)

Another form of cyst I will notice briefly and illustrate by an embryo Tetrarhynchobothrium, taken from the surface of the liver of the cero (*Cybium regale*). (Fig. 7.) This cyst is long and slender, about 10.5 mm. in length and 1.5 mm. in breadth, yellowish, opaque, but broken in places so as to show the outline of the blastocyst.

The blastocyst, which is set free when the walls of the cyst are ruptured, is long and slender, with a neck-like constriction at one end. (Fig. 8.) The head part thus set off is very changeable in form, expanding, contracting, moving up and down and from side to side, and revolving with a rotary movement on the constricted neck. The longer part or body of the blastocyst also undergoes much change of form by irregular contraction and expansion, but these movements take place more slowly than in the head. The color is ivory-white, slightly translucent when extended.

When compressed the embryo is discovered lying in a coil in the head of the blastocyst. (Fig. 8.) The parenchyma of the head part is now seen to be much coarser than that of the body part, the coarseness being due to the presence of numbers of large, oval, refractile fluid spaces. The parenchyma of the body is dense and finely granular, with smaller refractile masses than those in the head part. When the head part of the blastocyst is broken open the embryo is released, but instead of separating from the blastocyst, as in the case of the embryo Rhynchobothrium, the blastocyst remains attached to the body of the scolex much like the Cystocercus of Tænia. The method of release, however, is quite different from that of the Cystocercus of most Tæniæ. Instead of unfolding like the finger of a glove, the neck of the scolex first emerges in the form of a loop. (Fig. 9.) While in this position the head lies close beside the base of the neck in the vicinity of the contractile bulbs. The head is released by a simple straightening of the neck, which at its base, a short distance back of the contractile bulbs, remains attached to the head part of the blastocyst. (Fig. 11.) In this specimen, after the head of the scolex was released, the anterior part or head of the blastocyst continued for some time working backwards and forwards on the neck of the scolex like a movable barrel on a stationary piston. (Fig. 10.) Considerable pressure was applied for the purpose of making the scolex separate entirely from the blastocyst, but without causing it to break loose. When pressed out as far as it would go, it could be seen that there was an unbroken continuity between the scolex and blasto-

cyst. The posterior tapering end of the scolex, however, was clothed with the straight, fine hair-like bristles noticed in the Rhynchobothrium embryo.

The bothria are four in number, in opposite, lateral pairs, spreading from the front of the head. They are quite mobile, sometimes with the sucking-disks turned forward, sometimes backward, and with a retractile proboscis, armed with long, slender, slightly recurved hooks, belonging to each bothrium. (Figs. 11 *a* and 11 *b*.) The proboscides were everted but a short distance, but they were apparently as fully developed as those in the Rhynchobothrium embryo. The proboscis-sheaths were in spirals and the contractile bulbs slender. A reticulated system of vessels in the margins of the bothria, and sinuous longitudinal vessels behind the contractile bulbs and near the edges of the blastocyst, were made out in the living specimen.

In a specimen which was lightly stained with carmine and placed in glycerine, the scolex and body part of the blastocyst are red, while the globular head-like part of the blastocyst is a golden yellow, the carmine only showing faintly in some longitudinal central vessels, which apparently belong to the water vascular system. This same part in unstained specimens in alcohol is yellowish and more opaque than the body, which is white with a faint bluish tinge.

The development of this form differs at this period from that of the Rhynchobothrium described, in that the blastocyst is retained as a part of the scolex after the latter is released. I have repeatedly tried the experiment of opening blastocysts of these two types, with the results in every case as given above. In the one case, the embryo does not seem to have any vital connection with the blastocyst when the walls of the latter are broken. In the other, the embryo cannot be removed from the blastocyst except by breaking a connecting bond. Whether, in the latter instance, the blastocyst becomes a part of the adult strobile by giving rise to segments by absorption or otherwise, or whether it is evanescent, I have, as yet, had no opportunity of observing. —*Edwin Linton, Wood's Holl, Mass.*, August 31, 1886.

EXPLANATION OF PLATE.

FIG. 1. Cyst from peritoneum of *Pomatomus saltatrix* containing endocyst, enlarged about two diameters.

FIG. 2. Endocyst released from its cyst, somewhat flattened under the compressor so as to show the embryo Rhynchobothrium coiled up in the larger end, enlarged about two diameters.

FIG. 3. Embryo liberated from the endocyst (or blastocyst), lateral view, enlarged three diameters.

FIG. 3 *a*. One of the bothria, isolated, enlarged three diameters.

FIG. 4. The same flattened under the compressor, showing the contractile bulbs, the spiral proboscis-sheaths, and the protruded proboscides, enlarged six diameters.

FIG. 5. Posterior end of same, showing the termination of the vessels of the water vascular system and the fine hair-like bristles on the terminal papilla, enlarged twenty-five diameters.

PLATE X.

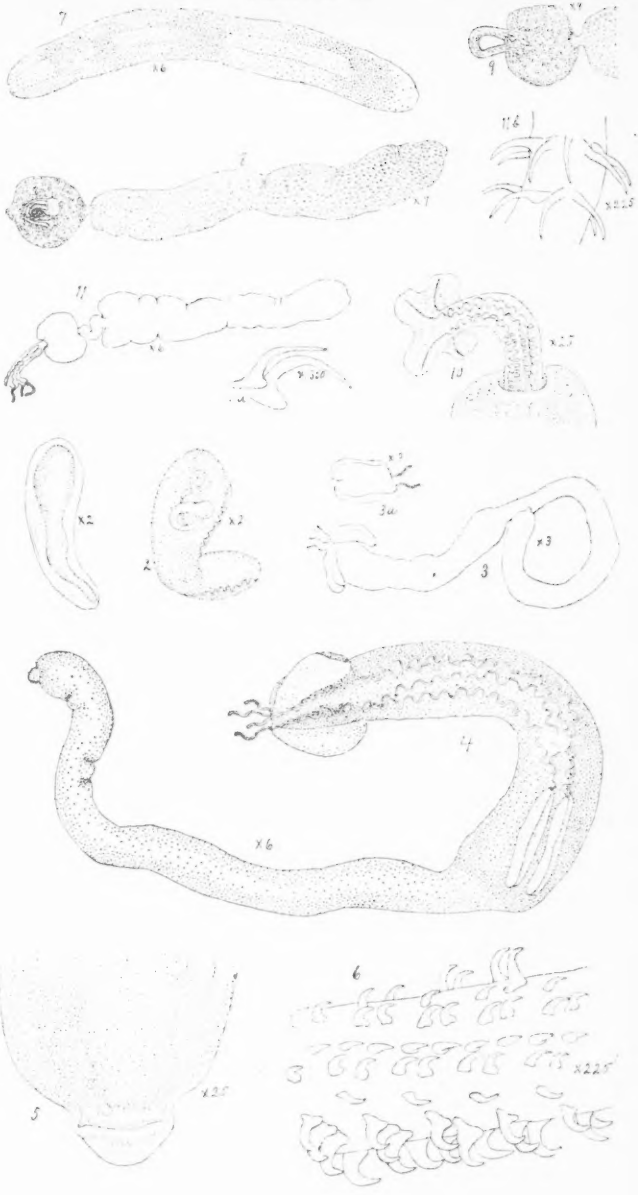

FIG. 6. Portion of proboscis, showing the five series of smaller hooks in front and a part of the larger hooks at the side, enlarged two hundred and twenty-five diameters.

FIG. 7. Cyst with endocyst, from surface of liver of *Cybium regale*, enlarged six diameters.

FIG. 8. Endocyst (blastocyst) liberated from its cyst, slightly compressed and showing the coiled embryo Tetrarhynchobothrium in the "head," enlarged nine diameters.

FIG. 9. The same, subjected to greater pressure, showing the embryo in the act of escaping from the blastocyst, enlarged nine diameters.

FIG. 10. The same, with head freed from the blastocyst, but still attached posteriorly to the "head" of the blastocyst. The bothria are seen from below as they are spread out and applied to the under glass of the compressor, enlarged twenty-five diameters.

FIG. 11. Outline of embryo with its blastocyst now attached like a rudimentary strobile, enlarged six diameters.

FIG. 11 *a*. Hooks near apex of proboscis, enlarged three hundred and fifty diameters.

FIG. 11 *b*. Portion of proboscis, enlarged two hundred and twenty-five diameters. All the figures drawn from life by Mrs. Edwin Linton.

Edwin Linton.

Development of Scorpions.—Kowalevsky and Schulgin have a paper on the development of *Androctonus ornatus* in the *Biologisches Centralblatt* (vi. pp. 525–532, 1886) which throws much light on these forms. As long as the egg remains in the ovarium it is not impregnated. Segmentation begins in the uterus. Their earliest embryo had the blastoderm completely formed at one pole of the egg, and at this time no nuclei were to be seen in the yolk. The first appearance of a differentiation into germ-layers was seen in the appearance of a swelling beneath the blastoderm, the cells of which arise from the pre-existing blastoderm cells and sink to the lower layer. This germinal area is circular in outline. The next step consists in the formation of the embryonic envelopes, which arise as a circular duplicature of the blastoderm in a manner analogous to those of Hexapods. Now the germinal area elongates, and one pole (cephalic) retains its breadth while the other (abdominal) becomes thicker and longer. During these processes many cells separate from the lower layer (ento-mesodermal) cells and sink into the yolk. These cells are not regarded as forming any of the tissue of the scorpion, but as digesting or softening the yolk. The entoderm arises as a layer of cells which separate from the ento-mesodermal layer and come to lie close upon the yolk. These rapidly spread over the yolk, which has already been enclosed by the amnion and serosa. The entoderm cells modify the outer layer of the yolk and then take up the modified deutoplasm, at the same time taking on the character of a cylindrical epithelium. The abdomen now grows out, and a portion of the mesenteron extends into it as far as the penultimate segment, where it unites with the proctodeum. The central portion of the mesenteron is latest in being differentiated into the tubular mid-gut and the

lobulated liver. The neural surface is outlined first, then the sides and hæmal wall.

The mesoderm is first differentiated when the entoderm separates from the ento-mesodermal layer, but for a long time it lingers in the germinal area. It then segments, and there is a preoral segment which contains a cavity like those of the post-oral series. The somatopleure is thicker than the splanchnopleure. Beyond the cœlom these layers unite and extend themselves dorsally between ecto- and entoderm and the marginal cells, changing their character separate, and become the primary blood-corpuscles. They fill the space on the back of the embryo, which the authors regard as the homologue of the segmentation cavity. Later the mesodermal layers unite—first above and later below—in this cavity, thus forming the central circulatory organ. Both the endothelium and the muscularis of the heart are of mesodermal origin, and even before the union of the layers of either side the histological differentiation of endothelium and muscular layers is evident.

The first traces of the nervous system appear as ectodermal thickenings. In each segment appear, on either side, two elevations. Of these the lateral give rise to the appendages, the median to the ganglia. At first these latter are simple ectodermal thickenings, but soon a rapid process of cell-proliferation takes place—first in the cephalic, then in the body region—in the following manner. In the head there are from fifteen to twenty places, in the other segments from ten to twelve, where this growth takes place. Each has the appearance of a groove, and in section these grooves are seen to be simple cavities which soon disappear by the growth of the bounding cells. In this way a very rapid proliferation is possible, but the authors do not consider the point whether it have any phylogenetic importance. The development of the brain is distinguished from that of the rest of the nervous system in that an accessory fold takes part in its formation. This fold was previously recognized by Metschnikoff in the scorpion and by Balfour in the spiders; it is distinct from the grooves mentioned above. A groove is formed around the periphery of the procephalic lobes, which becomes deeper and finally forms a right and a left cerebral vesicle. Next a second fold arises and forms a pouch on either side, the mouths of which are directed laterally. These are the first traces of the median eyes. The lateral eyes are developed independently, but their history has not been worked out.

The coxal glands, when first seen, appeared as a pair of tubes opening externally at the base of the second (?) pair of feet. Later the tubes were much coiled. Two portions could be distinguished,—an inner, arising from the splanchnopleure and communicating with the cœlom by a broad funnel, and an outer, formed by an ectodermal invagination. The lung-sacs appeared

late, as simple inpushings into a space rich with blood-corpuscles.

In this connection the reader is referred to this journal, vols. xix. p. 560; xx. pp. 666, 825, and 862.—*J. S. K.*

Polar Globules in the Crustacea.—The question whether there are polar globules formed in the maturation of the arthropod egg has long remained in doubt, and both Minot and Balfour have suggested that their absence was connected with the existence of parthenogenesis. Several writers have described and figured what might be polar globules, but their observations have contained a considerable element of doubt. Recently, August Weismann (*Zool. Anzeiger*, ix. 570–573, 1886) gives a preliminary account of the studies in this direction made by himself and his pupil, Chiyomatsu Ishikawa, on the parthenogenetic eggs of several Crustacea. In *Polyphemus oculus*, the ripe summer egg forms a polar globule in the normal manner, with a spindelkern, the long axis of which is at right angles to the surface of the egg. Then the egg enters the brood space, and there quickly forms a vitelline membrane. While this is going on the spindle divides, and the polar globule, which contains considerable protoplasm, becomes separated from the egg. This takes place at the animal pole of the egg, and then the inner end of the spindle becomes converted into the segmentation nucleus, and segmentation quickly follows. At the close of the second segmentation the polar globule itself divides and then quickly disappears; the authors think it is absorbed again by the egg. In *Bythotrepes longimanus* the process is much the same, except that the transformation of the proximal end of the spindelkern into the segmentation nucleus has not been seen. At the eight-cell stage the remnants of the polar globules are still visible, sunk between the cells, but with further development of the egg they sink deeper and finally disappear. Grobben had described polar globules in *Moina paradoxa* and Weismann confirms the observation, describing the process of formation as witnessed in the living egg. It does not differ materially from that outlined in the other species. In Leptodora, Weismann found a body very like the polar globules of Polyphemus and Bythotrepes, but did not see the method of their formation. In *Daphnia longispina* the spindle is apparently not so evident as in other cases, but its place is taken by a clear spot about half-way between the pole and the equator. Shortly after this the polar globule appears on the surface, its nucleus frequently retaining traces of the karyokinetic figures of formation while its circular or oblong body remains homogeneous. During the first and second segmentation of the egg the polar globule itself divides, the process being accompanied by karyokinesis and the resulting cells remaining close together. In this species the egg

completely fills its envelopes, and hence the polar globules are forced into the soft surface of the yolk, where they are with difficulty visible, at least without reagents. Leydig's observations, a quarter of a century ago, on the eggs of this same species showed bodies which have been supposed to be polar globules; but this could not have been the case, as these bodies which he describes were *outside* the chorion. A full paper is promised in the *Verhandlungen* of the *Freiburg Gesellschaft.*—*J. S. K.*

ANTHROPOLOGY.

The Races of Men.—A. Hennuyer, of Paris, will publish a series of volumes entitled "Bibliothèque Ethnologique, Histoire Générale des Races humaines." The first volume has already appeared, with the title:

Introduction à l'Étude des Races humaines, by A. de Quatrefages. There will follow:

Les Races Noires, by E. T. Hamy.
Les Races Jaunes, by M. J. Montano.
Les Races Rouges, by Lucien Biart.
History of the Mongols, by Jules Denitar.
Les Foulahs, by Dr. Tautain.
Les Aztèques, by Lucien Biart.

M. Quatrefages perfects the scheme of nature which has already appeared in his work, entitled "L'Espèce humaine," but which may not be familiar to all the readers of the AMERICAN NATURALIST.

EMPIRES.	KINGDOMS.	PHENOMENA.	CAUSES.
Inorganic	Sidereal	Keplerian movement	Gravitation.
	Mineral	Keplerian movement	Gravitation.
		plus physico-chemistry	Etherodynamics.
	Vegetal	Keplerian movement	Gravitation.
		plus physico-chemistry	Etherodynamics.
		plus vitality	Life
	Animal	Keplerian movement	Gravitation.
		plus physico-chemistry	Etherodynamics.
		plus vitality	Life.
		plus voluntary motion	Animal Spirit.
	Human	Keplerian movement	Gravitation.
		plus physico-chemistry	Etherodynamics.
		plus vitality	Life.
		plus voluntary motion	Animal Spirit.
		plus morality and religiosity	Human Spirit.

The views of monogenists and polygenists are presented in parallel columns, with monogenism as the personal equation of the author. It remains for a polygenist to prepare a similar table with as much fairness.

MONOGENISM.	POLYGENISM.
All men belong to one and the same *species*.	There are several *species* of men.
The differences which distinguish human groups are racial characters.	These differences are like specific characters.

MONOGENISM.

At what epoch did this single species appear on the surface of the globe? The question of antiquity is simple.

The human species first occupied only a circumscribed area of the globe. There is, then, a question of geographic origin to resolve.

The globe was peopled by migrations of which we have to search the traces and reconstruct the history.

To-day there probably exists no autochthonous people. America, in particular, and Polynesia were peopled only by colonists.

The human species inhabits to-day the entire globe,—the pole as well as the equator. It has, therefore, subjected itself to environments the most diverse. The question of acclimating in its widest and in its most special sense is necessarily raised.

In these migrations the human species, exposed to the action of new environments, could but be modified. This explains the formation of a certain number of races. Facts of the same nature passing in our day ought to arrest in a special manner the attention of anthropologists.

Crosses between human races in the past have given rise to races whose origin has been revealed by mixed characters imprinted by the parent types. We have to search the ethnic elements combined in peoples of this class.

Crosses between human races most diverse take place under our eyes. They have given birth to populations which enlarge from day to day and become more and more developed. The study of these populations presents a double and serious interest, in that it teaches us concerning the past and permits us to look into the future.

All actual populations have been more or less modified, either by environment or by crossing. The primitive type of humanity is lost. Even did it now exist we could not recognize it, in default of knowledge. Nevertheless, is it not possible to trace out some of the marks which would characterize it?

POLYGENISM.

At what epoch have appeared the different human species? Have they arisen simultaneously or successively? The question of antiquity is multiple.

The different species have first appeared on the spots where history announces their discovery. The question of geographic origin does not exist.

Migrations count for nothing in the general peopling of the earth. The question of primitive migrations exists not. The migrations of which history has preserved the memory are exceptional, and have exercised only an insignificant influence over the geographical distribution of peoples.

Excepting the European colonies founded in our day and those recorded in history, almost the entire globe has been peopled by autochthones. Specially, all the peoples of America and Polynesia were and could only be the products of the soil where modern explorers have found them.

The human peoples, constituting so many species originating on the spot, were made to live in the environments which encompass them. There is no general question of acclimating. We have only to study the special cases resulting from the expansion of modern populations.

The different human species have appeared with all the characteristics now marking them. Change of environment could not alter these. We have not to search how these distinctive characters could be brought out.

Populations with mixed characters are like the rest, distinct species and autochthonous. One need not disturb himself, therefore, about their pretended ethnic origins.

Crosses among human species can have no durable consequences. The resulting peoples would remain stationary or disappear if the crossing ceased. Their study possesses, therefore, no serious interest for us.

All the human species having appeared with their appropriate characters, such as we now recognize them, the problem of primitive man has no existence.

Some of the burning questions which M. Quatrefages discusses are the following:

The pretended Simian origin of man.

Incompatibility of Darwinism and polygenism.

Impossibility of going back to the first origin of the species.

The survival of fossil human races.

In his general treatment of his theme M. Quatrefages has followed the method of Prichard.

The Deities of the Navajos.—In the interesting account entitled "Some Deities and Demons of the Navajos," by Dr. W. Matthews, in the October issue of THE NATURALIST, he mentions the fact that the warriors offered their sacrifices at the sacred shrine of Thoyetli, in the San Juan valley. He says that the Navajos have a tradition that the gods of war, or sacred brothers, still dwell at Thoyetli, and their reflection is sometimes seen on the San Juan River. Dr. Matthews is certain the last part is due to some natural phenomenon. The following account seems to furnish a complete explanation of this last part of the myth. Several years ago, a clergyman, while travelling in the San Juan valley, noticed a curious phenomenon while gazing down upon the San Juan River as it flowed through a deep canyon. Mists began to arise, and soon he saw the shadows of himself and companions reflected near the surface of the river and surrounded by a circular rainbow, the "circle of Ulloa." They jumped, moved away, and performed a number of exercises, to be certain that the figures were their reflections, and the figures responded. There was but slight color in the rainbow. Similar reflections have no doubt caused the superstitious Indians to consider these reflections as those of their deities.—*G. A. Brennan, Roseland, Cook County, Ill.*, January 12, 1887.

Dr. Franz Boas, the successful explorer of the polar countries north of Hudson's Bay, has just returned to the East from a three months' trip to the east side of Vancouver's Island, B. C., and the mainland opposite. He visited there a considerable number of tribes, most of which, he thinks, belong to the Selish family, though he entertains doubts whether the Kwákiūtl belong there or not. As far as their intercourse with the whites is concerned, they are harmless and friendly; but outside of Nanaimo and Victoria the white population there is very sparse. The Gospels of Matthew and John have been translated into the Kwákiūtl language of Fort Rupert, a post now abandoned. Dr. Boas intends to publish soon a part of his exploratory results in this country, with illustrations. A pamphlet upon the Bilkúla, or Vilxúla, farther north, of whom he saw some individuals in Germany, was issued by him, with photographic portraits of these Indians, in the *Transactions of the Anthropologic Society of Berlin*. He pays more attention than explorers commonly do to

the collecting of myths, traditions, and vocabularies. To get these he was obliged to avail himself of the Chinook jargon, which he has mastered in a pretty short lapse of time. The songs and melodies which Professor C. Stumpf, of Halle, obtained from the Bilkúla Indians travelling in Germany were published by him in an article inserted in the *Zeitschr. für Musikwissenschaft*, 1886, pp. 405–426, and two articles by Dr. Boas (with another by Goeken) upon the same tribe are to be found in the "Original-Mittheilungen der Ethnolog. Abtheilung der Kön. Museen zu Berlin," 1886, pp. 177–186.—*A. S. Gatschet.*

MICROSCOPY.[1]

Note on the Practical Study of Moulds.—It is well known that the study of moulds may be greatly facilitated by following their development in gelatine films, or other solid substrata, spread on glass slides; but the value of the method for classes in elementary biology has not been sufficiently recognized. The following application of the method is perhaps already in use; but I wish to call attention to it as simple and practical, and especially as affording a ready means of making very clear and beautiful permanent preparations.

The spores are sown with a needle-point in films, consisting of a modification of Pasteur's or Mayer's fluid (with pepsin) thickened with Iceland moss. In this medium moulds grow freely in the moist chamber. They may be examined either fresh or after treatment with iodine, which scarcely colors the substratum. For the purpose of making permanent preparations the culture-slides are transferred directly from the moist chamber to a saturated solution of eosin in ninety-five per cent. of alcohol, a fluid by which the moulds are at once fixed and stained. After twenty-four hours (or, preferably, three or four days) the preparations are washed in ninety-five per cent. alcohol until the color nearly disappears from the substratum, cleared with oil of cloves, and mounted in balsam. All stages may thus be prepared. The mycelia, conidia, etc., appear of an intense red color, while the substratum is scarcely stained. Alcoholic fuchsin may be used instead of eosin, though inferior to it; but other dyes (of which a considerable number have been tested) color the substratum uniformly with the moulds, and are therefore useless. Eosin preparations made more than a year ago do not yet show the slightest alteration of color. The best results have thus far been obtained with *Penicillium*, *Eurotium*, and certain parasitic forms. *Mucor* gives less satisfactory preparations, since it is always more or less shrunken by the alcohol. Fair preparations of yeast may be made by mixing it with the liquefied medium and spreading the mixture on glass slides, which, after solidification of the films,

[1] Edited by C. O. WHITMAN, Ph.D., Milwaukee, Wisconsin.

are placed in the eosin solution, as in the case of mould-cultures.

For preparing the cultures, Pasteur's or Mayer's fluid, with pepsin [see Huxley and Martin's Practical Biology], but not containing more than five per cent. of sugar, is heated with Iceland moss until the mixture attains such a consistency that it will just solidify when cold (fifteen to thirty minutes). It is then filtered by means of a hot filter into small glass flasks, which are afterwards plugged with cotton-wool, and sterilized at 65° to 70° C. by the ordinary method. When required for use, the mass is liquefied by gentle heat, poured on the slides, and allowed to solidify. The spores are sown by a needle-point, touched once to a mass of spores, and thereupon drawn across several films in succession, the spores being thus scattered along the track of the needle, and more or less completely isolated. Care must be taken that the quantity of sugar be not too great. The films should be tolerably thick, and the atmosphere of the moist chamber such that the films neither dry nor liquefy.

[My thanks are due to Miss Harriet Randolph, whose experiments with various substrata and staining-fluids led to the adoption of the method described].—*Edmund B. Wilson, Biological Laboratory of Bryn Mawr College.*

SCIENTIFIC NEWS.

—W. Baldwin Spencer, of Lincoln College, Oxford, has been appointed to the chair of Biology in the University of Melbourne. He is a pupil of Professor H. N. Moseley. He has published papers on the urinary organs of Amphipods and on the neurenteric canal of the Batrachia, but probably his best known work is that in which he shows that the pineal gland is the remains of the third vertebrate eye, and that in certain existing lizards it still retains all of its optical structure, though it is probably not functional.

—The Buffalo Society of Natural Science is at last provided with suitable quarters. It has long occupied rooms in the old building of the Young Men's Association of Buffalo, but they have been inadequate for the accommodation of the library and collections. The Young Men's Association has also been cramped for room, and a few years ago they began the erection of a new building, which has at last been completed, at a cost of about three hundred thousand dollars. It occupies a very eligible site, and architecturally would be an ornament to any city. The building was dedicated with appropriate ceremonies Monday evening, February 7. It will be occupied by the Buffalo Library, the Buffalo Historical Society, the Buffalo Academy of Fine Arts,

and the Buffalo Society of Natural Science. The latter society have ample accommodations in the western portion of the basement. Professor D. S. Kellicott, the president of the Society of Natural Science, gave the address for that society. This society was organized in December, 1861, and its history has been one of continual progress. It has accumulated a fine museum, which is especially rich in local forms. The collection of fossils of the Waterlime group is noteworthy. Nowhere in America can be seen a better collection of Eurypterids, those strange Limulus-like forms which were a prominent feature in the Palæozoic seas. The first president, the late Judge Clinton, gave the society his valuable herbarium, while its entomological collection contains many of the type-specimens of the late Colman T. Robinson, A. R. Grote, L. F. Hervey, D. S. Kellicott, and others. The library is especially rich in entomological works. At present the society is somewhat cramped for funds, but in time it will be amply provided with money. Its late president, Dr. George E. Hayes, left about two hundred thousand dollars, which, after the death of his widow, are to come into the possession of the society. At present its funds are principally from the bequest of the late Professor C. T. Robinson. We are glad to learn that the meetings of the society have never been better attended or the discussions and papers more interesting than at present.

—The Johns Hopkins University will have its marine laboratory this year at Nassau, N. P. The party will sail about March 1, and will stay until July 1, if not longer. It is proposed to hire a building for the laboratory. Dr. W. K. Brooks will be in charge as usual.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Boston Society of Natural History.—January 19, 1887.—On account of the inclemency of the weather the regular paper of the evening was postponed, and Dr. J. S. Kingsley gave some of his recent observations on the embryology of Arthropods. A peculiar feature was noticed in the development of Decapods, in that the germ from the eyes to the tip of the abdomen was actually longer in early than in later stages. An explanation of this fact is difficult. Dr. Kingsley also referred to the classification of Arthropods and their derivation from Worms. Dr. C. S. Minot gave a *résumé* of observations on the origin of the tracheæ of Hexapods, and suggested that they supported Dr. Kingsley's view that these organs were not homologous in Arachnids and Hexapods. Professor W. T. Sedgwick spoke of the extrusion of trichocysts in Paramecium under the stimulation of tannic acid.

February 2.—Dr. Kingsley gave his paper postponed from the preceding meeting. He maintained that the terms "centrolecithal" as applied to Arthropod eggs, and "superficial" as de-

scribing their segmentation, were totally erroneous. A superficial segmentation is of necessity meroblastic. In Arthropod eggs the first segmentations are central, and the blastoderm is formed by migration of the resulting cells to the surface. With this new view it is a comparatively easy matter to reconcile the process of gastrulation in the Hexapods with that of other Metazoa. It affords an excellent example of the theory of acceleration, or concentration of development, held by Professors Cope and Hyatt. The nauplius of Crustacea was regarded as an adaptive stage, and one which had far less phylogenetic significance than was usually assigned it. Professor Hyatt spoke of the early development of the sponges, and instanced cases which paralleled and supported the views of Dr. Kingsley.

General meeting, Wednesday evening, February 16.—The following papers were read: "On the Range of Variations in the Human Shoulder-Blade," by Dr. Thomas Dwight; "A Study of North American Geraniaceæ," by Professor Wm. Trelease.

Middlesex [Mass.] Institute.—January 19, 1887.—Mr. Frank S. Collins read a paper on "Curious Conceits of the Older Herbalists," quoting from Gerarde and earlier writers.

New York Academy of Sciences.—Monday evening, February 7.—The following paper was read: "Report upon the Pink Dolomite recently obtained near Morrisania, with Analysis," by Mr. A. B. Bjerregaard.

Monday evening, February 14.—The following paper was read: "The Landskibet, or Viking Ship, discovered near Gokstad, Norway, in 1880" (with lantern illustration), by Dr. John S. White.

Biological Society of Washington.—February 5, 1887.—The following communications were read: Mr. William T. Hornaday, "The Last of the Buffalo;" Mr. Richard Rathbun, "Ocean Temperature Charts in Connection with Studies in Geographical Distribution;" Dr. C. Hart Merriam, "Contributions to North American Mammalogy. Description of a New Species of Wood-Rat" (*Neotoma*); Mr. Henry W. Elliott, "Ridgeway's Nomenclature of Colors for Naturalists;" Dr. L. Stejneger, "Exhibition of New Species of Birds from the Sandwich Islands;" Dr. Tarleton H. Bean, "Variation under Domestication of the Rainbow Trout" (with exhibition of specimens).

February 19.—The following communications were read: Professor E. D. Cope, "An Undescribed Species of Snake from the District of Columbia;" Professor E. D. Cope, "The Hyoid Apparatus in the Urodele Batrachians;" Dr. George Vasey, "Remarks on a Recent Collection of Mexican Grasses, made by Dr. E. Palmer;" Professor R. E. C. Stearns, "Notes on Physianthus as a Moth-trap."